FINAL

Confirmation Sampling and Analysis Report for Building 406

Offutt Air Force Base
Nebraska

Prepared For

Air Force Center for Environmental Excellence
Brooks Air Force Base, Texas

and

55 CES/CEVR
Headquarters Air Combat Command (ACC)
Offutt AFB, Nebraska

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February 1999

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PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900 • Denver, Colorado 80290

FINAL

CONFIRMATION SAMPLING AND ANALYSIS REPORT FOR BUILDING 406 OFFUTT AIR FORCE BASE, NEBRASKA

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Contract F41624-92-8036, Delivery Order 17

February 1999

Prepared by:

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LIST OF ACRONYMS AND ABBREVIATIONS

ACC	Air Combat Command
ACL	Alternative Compliance Limit
AFCEE	Air Force Center for Environmental Excellence
AFB	Air Force base
ASTM	American Society for Testing and Materials
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CES/CEVR	Civil Engineering Squadron/Environmental Division
COPC	chemical of potential concern
ES	Engineering-Science, Inc.
IDW	investigation-derived waste
JP-4	jet propulsion grade 4 [fuel]
MCL	maximum contaminant limit
µg/L	micrograms per liter
mg/kg	milligram(s) per kilogram
mg/L	milligrams per liter
MP	monitoring point
MS	matrix spike
MSD	matrix spike duplicate
NDEQ	Nebraska Department of Environmental Quality
NFRAP	no further response action planned
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbon
Parsons ES	Parsons Engineering Science, Inc.
PEL	permissible exposure limit
PID	photoionization detector
POL	petroleum, oil, and lubricant
ppmv	parts per million, volume per volume
QA	quality assurance
QC	quality control

RAC	Remedial Action Class
RBCA	risk-based corrective action
RBSL	risk-based screening level
SAC	Strategic Air Command
SAP	Sampling and Analysis Plan
SSL	soil screening level
SSTL	site-specific target levels
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
TVH	total volatile hydrocarbons
TVHA	total volatile hydrocarbon analyzer
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
VW	vent well
yr	year
$\mu g/m^3$	micrograms per cubic meter

SECTION 1

INTRODUCTION

1.1 PURPOSE

This confirmation sampling and analysis report for Building 406 at Offutt Air Force Base (AFB), Nebraska has been prepared by Parsons Engineering Science, Inc. (Parsons ES, formerly known as Engineering-Science, Inc.[ES]) for submittal to the Nebraska Department of Environmental Quality (NDEQ); the United States (US) Air Force Center for Environmental Excellence (AFCEE), Brooks AFB, Texas; and 55th Civil Engineering Squadron, Environmental Group (55th CES/CEVR), Headquarters Air Combat Command (ACC), Offutt AFB, Nebraska. This report has been prepared as part of the AFCEE Extended Bioventing Project (Contract F41624-92-8036, Delivery Order 17). The purpose of this report is to document the effectiveness of implemented soil remediation activities (*in situ* bioventing) at Building 406 and to demonstrate compliance with NDEQ requirements and risk-based corrective action (RBCA) goals for soil for site closure.

1.2 PROJECT BACKGROUND

Since 1992, Offutt AFB has participated in two AFCEE-sponsored bioventing projects: presently, the Extended Bioventing Project; and formerly, the Bioventing Pilot Test Initiative. The Bioventing Pilot Test Initiative included conducting more than 135 *in situ* bioventing pilot tests at 48 Air Force installations nationwide. These tests were designed to collect data on the effectiveness of bioventing for the remediation of soil contaminated with fuel hydrocarbons (e.g., JP-4 jet fuel, diesel fuel, gasoline, or heating oil). Building 406, along with three other sites at Offutt AFB, was selected for inclusion in the Bioventing Pilot Test Initiative project. The initial bioventing pilot testing effort at Building 406 consisted of installing four bioventing air-injection vent wells (VWs) and three soil gas monitoring points (MPs); collecting initial soil and soil gas samples; performing initial *in situ* respiration tests and fuel biodegradation measurements; air permeability testing; installing a pilot-scale bioventing system; and operating the installed system for two years. Complete bioventing pilot testing results are presented in the *Draft Interim Pilot Test Results Report for Building 406, Offutt AFB, Nebraska* (ES, 1994).

Following 2 years of bioventing under the Bioventing Pilot Test Initiative project, Building 406 was selected for inclusion in the AFCEE Extended Bioventing Project. This ongoing project involves 52 *in situ* bioventing sites at 32 military installations nationwide. The bioventing system at the Building 406 site was operated and

monitored for 1 year (from October 1995 to October 1996) as an Option 1 site of the AFCEE Extended Bioventing Project. In October 1996, the blower system was shut down for approximately 30 days to allow soil and soil gas conditions to reach equilibrium. After the blower shutdown period, soil gas samples were collected and analyzed, and respiration tests were conducted (Parsons ES, 1997a). The bioventing system was re-started and re-optimized following the completion of this 3-year testing event. Based on the respiration test and soil gas sampling results, it was decided to allow the system to operate for an additional year (November 1996 through December 1997) prior to performing confirmation soil sampling.

Under the Extended Bioventing Project, Building 406 was funded for confirmation soil sampling (contractually referred to as an Option 2) to document the effectiveness of soil remediation at the site and to demonstrate compliance with NDEQ requirements for site closure and the American Society for Testing and Materials (ASTM) RBCA criteria (ASTM, 1995). In preparation for the confirmation sampling, a site-specific sampling and analysis plan (SAP) was prepared by Parsons ES (1997b) for NDEQ, AFCEE, and Offutt AFB. A copy of the SAP is provided as Appendix A.

Following NDEQ, AFCEE, and Offutt AFB approval of the SAP, confirmation soil sampling was conducted at Building 406 from 8 through 10 December 1997. Confirmation soil sampling activities consisted of advancing six boreholes to depths up to 12 feet below ground surface (bgs), and analyzing selected soil samples for hydrocarbon constituents. Soil sampling analytical results are used to support site closure. A total of 12 soil samples were submitted for analysis from the six boreholes.

1.3 SUMMARY OF CONFIRMATION SAMPLING RESULTS

Site-related contaminants include total petroleum hydrocarbons associated with JP-4 jet fuel. Confirmation soil samples were analyzed for benzene, toluene, ethylbenzene, and total xylenes (BTEX), total petroleum hydrocarbons (TPH), and polynuclear aromatic hydrocarbons (PAHs). During the course of bioventing treatment, the site-wide maximum measured total BTEX concentration was reduced from 675 milligrams per kilogram (mg/kg) to 24.77 mg/kg and the maximum TPH concentration was reduced from 11,700 to 1,030 mg/kg.

The objective of the confirmation soil sampling was to demonstrate that there is not an unacceptable risk associated with residual petroleum hydrocarbons in vadose zone soils. Alternative compliance limits (ACLs) were developed for existing and possible future completed receptor exposure pathways. It was determined that the only current potentially completed exposure pathway is inhalation of vapors migrating from contaminated soil into existing nearby commercial/industrial buildings. However, a possible future migration pathway involving soil contamination is soil vapor intrusion into any future buildings that may be constructed at the currently vacant site. The toxicity-based ACLs were developed using the tiered approach presented in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (ASTM, 1995).

The analytical results from the confirmation soil sampling event were compared to the ACLs developed using the tiered approach. The majority of detected PAHs were eliminated from further consideration based on physical properties that precluded them from an inhalation route of exposure. Of the remaining BTEX and PAH compounds, only the maximum detections of benzene and naphthalene exceeded their respective Tier 1 risk-based screening levels (RBSLs) which are developed based on very conservative non-site specific assumptions. Only the maximum benzene concentration exceeded the Tier 2 site-specific target levels (SSTLs) developed using site-specific data. Finally, a Tier 3 analysis was performed to calculate the maximum expected benzene concentration within an enclosed area of an on-site building based on the maximum detected benzene concentrations. The results of the Tier 3 analysis indicates that the maximum indoor air concentration of benzene in a future on-site building due to site soils is well below applicable exposure limits.

Based on the results of the risk-based analysis of the confirmation soil sample analytical results, there does not appear to be an unacceptable risk associated with residual fuel hydrocarbons in site soils. Therefore, it is recommended that a no further remedial action planned (NFRAP) decision be made and the site be closed. It is also recommended that the bioventing system be removed from the site and the VWs and MPs be properly abandoned.

1.4 REPORT ORGANIZATION

This site confirmation sampling and analysis report consists of six sections, including this introduction, and three appendices. Section 2 includes a brief site description and history. Section 3 is a description of the confirmation soil sampling activities conducted at the site. Section 4 contains a summary of confirmation sampling analytical results and presents the proposed risk-based ACLs. Section 5 presents conclusions and the recommendation for site closure, and references used in preparation of this report are provided in Section 6.

Appendix A presents a copy of the confirmation SAP for Building 406 which includes a detailed summary of previous site investigations. Appendix B presents laboratory analytical data for site environmental and quality assurance/quality control (QA/QC) samples. Calculations for the risk determination are provided in Appendix C.

SECTION 2

SITE DESCRIPTION AND HISTORY

2.1 SITE LOCATION AND HISTORY

Offutt AFB is located immediately south of Bellevue, Nebraska, approximately 10 miles south of Omaha. In 1896, Fort Crook was established at the location of the base and became Offutt Field in 1924. In January 1948, Offutt Field was transferred to the Department of the Air Force and became Offutt AFB. The base was the Headquarters, Strategic Air Command (SAC) from 1948 until 1992 when it became the 55th Wing of the ACC.

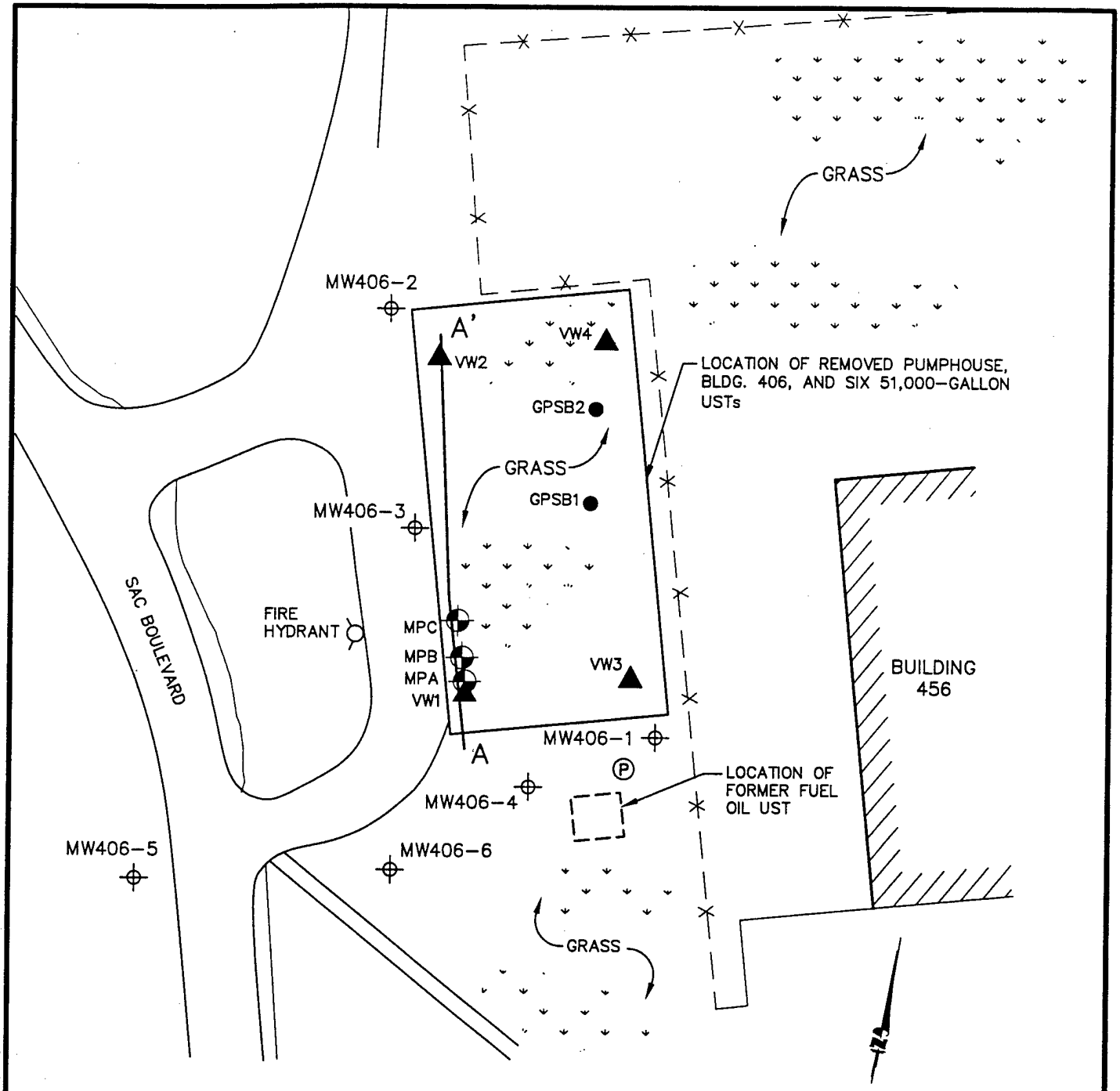
Building 406 was a fuel pumphouse serving six large underground storage tanks (USTs), located just east of SAC Boulevard at the northeast corner of the base golf course. A layout of the Building 406 site is shown on Figure 2.1. Each of the six USTs at the site were reported to be 60 feet long and 12 feet in diameter with a capacity of 51,000 gallons. One of these tanks contained deicing fluid and the others contained JP-4 and (formerly) aviation gasoline (AVGAS). A seventh UST, located to the south of the others (Figure 2.1), was reported to have contained fuel oil. This tank was 6 feet long, 4 feet in diameter, and had a capacity of 560 gallons (Terracon Environmental, Inc., 1993). The fuel pumphouse and associated tanks were taken out of service in March 1992.

Contaminated soil was observed during removal of the six large USTs in October 1993, and was reported to the Nebraska State Fire Marshal Flammable Liquid Storage Division and the NDEQ in the tank closure assessment report (Terracon Environmental Inc., 1993). Contaminated soils removed during the tank removal project were returned to the excavations. No evidence of contamination was observed during removal of the fuel oil UST located to the south of the others. Investigations and remedial actions performed subsequent to UST removal are described in detail in Section 2.3.

2.2 TOPOGRAPHY, HYDROLOGY, GEOLOGY, AND HYDROGEOLOGY

2.2.1 Topography and Surface Hydrology

Offutt AFB is located on a dissected Pleistocene terrace physiographic embankment and Missouri River Valley bottomland (Woodward Clyde Consultants, 1995). The Building 406 site is located on the Pleistocene terrace approximately 995 feet above mean sea level (amsl). Surface water in the vicinity of Building 406 is primarily



LEGEND

- MW406-1 — GROUNDWATER MONITORING WELL
- VW1 — AIR INJECTION VENT WELL
- MPA — MONITORING POINT
- GPSB1 — SOIL SAMPLING LOCATION
- (P) — POWER PANEL (230V,110V)
- FENCE
- A——A' — LOCATION OF HYDROGEOLOGIC CROSS-SECTION

FIGURE 2.1

SITE LAYOUT

Confirmation Sampling and Analysis Report
for Building 406 Site
Offutt Air Force Base, Nebraska

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controlled by the storm sewer system which drains to Papillion Creek. Papillion Creek is located about 2,400 feet southwest of the site. The Missouri River is approximately 1 mile from the eastern boundary of the base and approximately 2.5 miles from the Building 406 site.

2.2.2 Geology

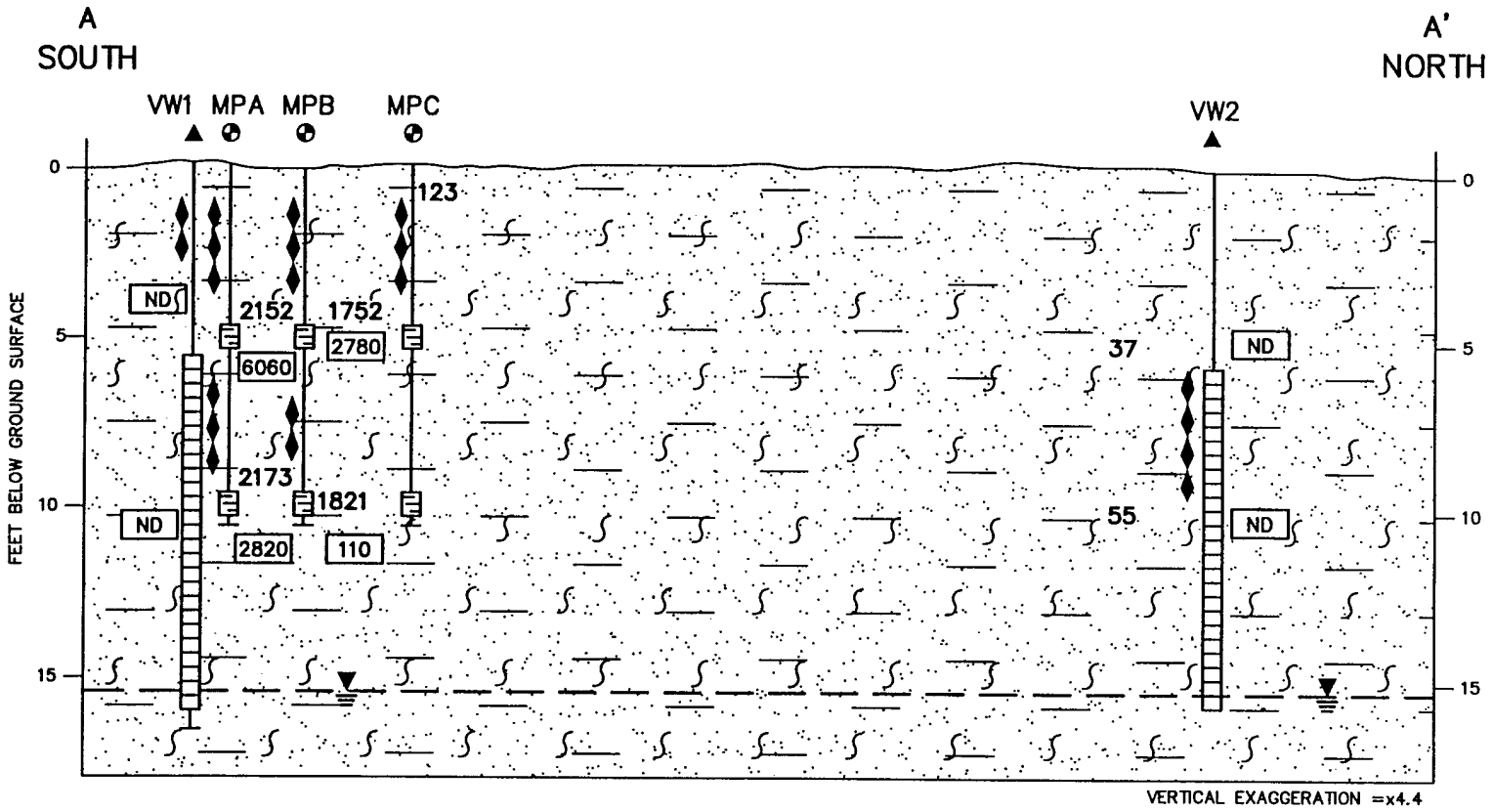
The Pleistocene terrace geologic profile is typically surficial fill soils; loess; Pleistocene terrace alluvial clays, silts, and sands; and a clay-rich glacial till-outwash sand complex overlying Pennsylvanian bedrock. The Pennsylvanian bedrock is primarily composed of limestone and shales (Woodward Clyde Consultants, 1995).

During installation of the bioventing pilot test components, soil samples were collected and analyzed for grain size distribution by a geotechnical laboratory. The soil beneath the Building 406 site is characterized by silt with some clay and a trace of sand to a depth of at least 25 feet bgs (ES, 1994). These observations suggest the former tanks were located within the surficial fill and loess deposits. Bedrock was not encountered during any investigation activities, all of which terminated at depths of 25 feet bgs or less. A hydrogeologic cross-section of the site is presented in Figure 2.2. The trace of the cross section is shown on Figure 2.1.

2.2.3 Hydrogeology

The unconsolidated materials resting on the Pennsylvanian bedrock comprise the principal aquifer beneath the site. The clay-rich glacial till is considered an aquitard for the unconfined aquifer present in overlying Pleistocene alluvial deposits and loess (Woodward Clyde Consultants, 1995). The water table beneath the Building 406 site was measured at a depth of approximately 17 to 20 feet bgs in February 1994 but was observed to be approximately 16 feet bgs during the installation of the bioventing system in October 1993. Groundwater flow is to the west-southwest as shown in Figure 2.3. Limited hydraulic conductivity data for the area indicate an alluvial aquifer hydraulic conductivity of 0.0002 centimeters per second (cm/sec) (Terracon Environmental Inc., 1994). Assuming an average hydraulic gradient of 0.01 foot per foot (estimated from the 1994 groundwater elevation data) and an effective porosity of 0.40, the groundwater flow velocity is approximately 5 feet per year.

Groundwater is not currently used as a potable water source on the Offutt AFB property. However, there are two abandoned groundwater production wells located on the base, an emergency well (Well No. 9) in the underground command center at Facility 500, and an emergency standby fire protection well (Well No. 5) on the east side of the petroleum, oil, and lubricant (POL) yard. Two domestic wells are located approximately 2,000 feet south-southwest (downgradient) of the base boundary (Woodward Clyde Consultants, 1995).



LEGEND

- MPA — MONITORING POINT
- VW1 — INJECTION VENT WELL
- 2173 — FIELD SCREENING RESULTS FOR TOTAL VOLATILE HYDROCARBONS (ppmv)
- 2820 — LABORATORY RESULTS FOR SOIL TOTAL PETROLEUM HYDROCARBONS (mg/kg)
- FUEL ODOR DETECTED DURING DRILLING
- GROUNDWATER ELEVATION (10/93)
- GEOLOGIC CONTACT DASHED WHERE INFERRED
- MONITORING POINT SCREENED INTERVAL
- SCREENED WELL INTERVAL
- ND — NOT DETECTED

LITHOLOGIC DESCRIPTION

- SILT WITH CLAY AND SAND

0 12.5 25
FEET

FIGURE 2.2

HYDROGEOLOGIC CROSS SECTION A-A'

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for Building 406 Site
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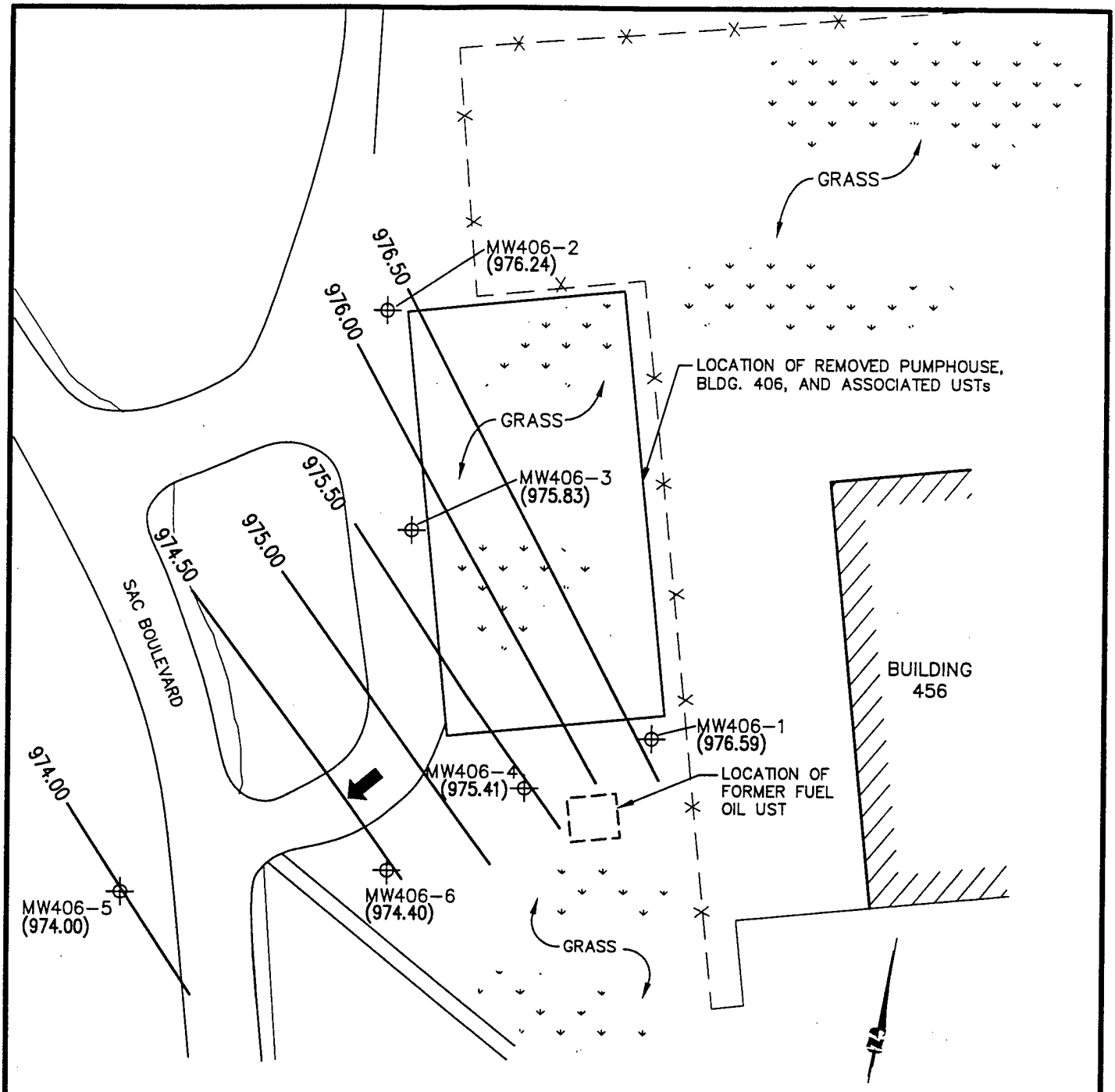

LEGEND

MW406-1 — MONITORING WELL

(976.59) — GROUNDWATER ELEVATION, FEBRUARY 1994 (feet above mean sea level)

FENCE

GROUNDWATER FLOW DIRECTION

975.00 — LINE OF EQUAL GROUNDWATER ELEVATION (feet above mean sea level)

FIGURE 2.3

GROUNDWATER ELEVATIONS AND FLOW DIRECTION FEBRUARY 1994

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for Building 406 Site
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2.3 PREVIOUS INVESTIGATIONS

2.3.1 1993 Tank Removal by Terracon Environmental, Inc.

All seven USTs associated with Building 406 were removed, and a tank closure assessment was performed in October 1993 by Terracon Environmental Inc. (1993). Upon removal, none of the tanks showed visible signs of leaks; however, contaminated soils were observed in the removal excavation for the six 51,000-gallon USTs. Soils had a greenish color and a distinctive hydrocarbon odor. Composite soil sample headspace readings indicated total volatile hydrocarbons (TVH) in the range of 200 to 400 parts per million volume per volume (ppmv). No indication of soil contamination was observed in the excavation for the 560-gallon fuel oil UST. Soil samples were collected from both excavations, and the results are presented in Table 2.1 of Appendix A (Terracon Environmental Inc., 1993).

The excavation for the six larger tanks was at least 16 feet deep, which was sufficiently deep enough to accumulate groundwater. Groundwater samples were collected from the excavation and analyzed for total recoverable petroleum hydrocarbons (TRPH) by US Environmental Protection Agency (USEPA) Method 418.1 and for benzene, toluene, ethylbenzene, and total xylenes (BTEX) by USEPA Method SW8020. The groundwater analytical results are presented in Table 2.2 of Appendix A.

2.3.2 1994 Soil and Groundwater Investigation by Terracon Environmental, Inc.

Six soil boreholes were advanced and completed as monitoring wells between 27 August 1993 and 21 February 1994 (Terracon Environmental, 1994). Figure 2.3 shows the locations of these monitoring wells. During installation of the boreholes, soil samples were collected at 5-foot intervals and screened for volatile organic compounds (VOCs) using a photoionization detector (PID). The results, presented in Table 2.3 of Appendix A, indicate that soils at wells MW406-1 and MW406-3 are contaminated near the groundwater surface and that there was significant vadose zone contamination only at MW406-4.

Groundwater samples were collected from each well between 20 December 1993 and 21 February 1994 and were analyzed for BTEX by USEPA Method SW8020 and TRPH by USEPA Method 418.1 (Terracon Environmental, 1994). The results, presented in Table 2.4 of Appendix A, indicate minor impact to groundwater quality in the immediate vicinity of the former tanks. No drinking water maximum contaminant levels (MCLs) were exceeded. No further groundwater investigation has been performed at this site.

2.3.3 1993-1997 Bioventing Pilot Test by Parsons ES

In October 1993, a full-scale bioventing system was installed at the Building 406 site by ES (1994) as part of the AFCEE Bioventing Pilot Test Initiative Project. The full-scale bioventing system consisted of four vent wells (VWs), three multi-depth vapor monitoring points (MPs), and a blower unit. Figure 2.4 shows the locations of the

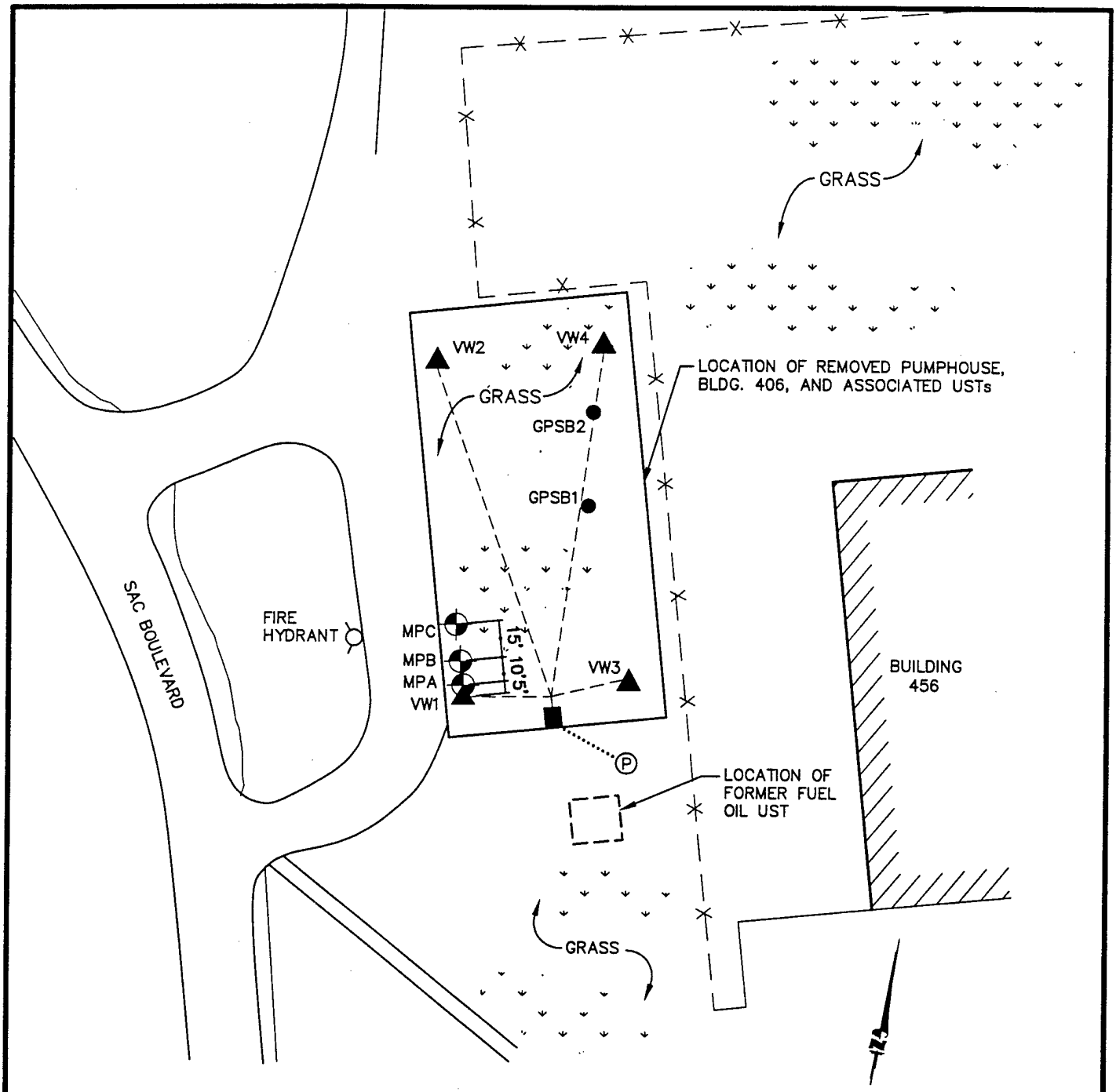

FIGURE 2.4

AS-BUILT VENT WELL, MONITORING POINT, AND BLOWER LOCATIONS

Confirmation Sampling and Analysis Report
for Building 406 Site
Offutt Air Force Base, Nebraska

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bioventing system components. Pilot testing activities performed during installation included respiration and air permeability testing and soil and soil gas sampling.

Soil samples were collected as part of the investigation at the time of system installation. All samples were field screened with a PID and 12 soil samples were submitted for laboratory analysis of BTEX, TRPH, nutrients, moisture, and grain-size distribution. Soil gas samples also were collected from VW1 and the 10-foot intervals of MPA and MPB, and analyzed for BTEX and TVH. Based on field screening results, hydrocarbon contamination was generally present from about 5 to 16 feet bgs. Contaminated soils were encountered in all MP boreholes with the greatest contaminant concentrations occurring at 10 feet bgs at MPA.

The Bioventing Pilot Test Initiative Project provided for 1 year of system operation (from October 1993 to October 1994) followed by soil gas sampling and respiration testing. However, the NDEQ, in cooperation with AFCEE, funded an additional year (year 2, from October 1994 to October 1995) of system operation followed by soil gas sampling and respiration testing. The Building 406 site was funded for a third year of operation and monitoring under the Extended Bioventing Project. The third year of operation and maintenance support continued through November 1996 (the 3-year sampling event). Soil sampling was not performed during the 3-year sampling event. The bioventing system has been operating since the November 1996 sampling event, except during a short period following blower unit failure. The blower was subsequently replaced.

The SAP, presented in Appendix A, summarizes the soil and soil gas analytical results of the samples collected at the time of bioventing system installation and during the extended testing. Overall, the soil analytical results indicate that bioventing has reduced TRPH and BTEX concentrations in soils at the Building 406 site.

The SAP provides a more detailed description of the remedial actions performed at the Building 406 site to date. Further details of the bioventing system installation and preliminary pilot test and analytical results are presented in the bioventing pilot test work plan and draft interim pilot test results report (ES, 1994). The 1-year, 2-year, and 3-year test results are summarized in a 30 January 1995 letter (Parsons ES, 1995), a 25 February 1996 memorandum (AFCEE, 1996), and a 29 January 1997 letter (Parsons ES, 1997a), respectively.

2.3.4 Results Summary

Based on the results of the previous investigations, the former JP-4 USTs have been identified as the probable source of the petroleum hydrocarbon contamination at the Building 406 site. Investigation results indicate that the majority of the vadose zone contamination has been limited to the soils near the former USTs. Field screening of soil samples collected during installation of the monitoring wells indicated that vadose zone soils beyond the limits of the UST excavation have not been significantly impacted (Table 2.1 of Appendix A). Therefore, the majority of the vadose zone contamination is within the bioventing system treatment area, which is considered to be the footprint

of the area occupied by former Building 406 (fuel pumphouse) and associated USTs (Figure 2.4). Analytical results from samples collected during bioventing testing indicate that significant reductions in soil TRPH and BTEX concentrations have occurred as a result of bioventing.

Analytical results of groundwater samples indicated minor impact on groundwater quality in the immediate vicinity of the former tanks. No drinking water MCLs were exceeded. Based on conversations with the NDEQ, no further groundwater investigation is required at this site (Nancy Mann, 1997).

SECTION 3

SITE CONFIRMATION SAMPLING AND ANALYSIS ACTIVITIES

The purpose of this section is to summarize site confirmatory soil sampling activities, including sampling locations and sampling depths, sampling procedures, analytical methods used, and QA/QC procedures followed. These methods/procedures are described in more detail in the closure SAP (Appendix A). The closure SAP was implemented by qualified Parsons ES scientists trained in conducting soil sampling, records documentation, and chain-of-custody procedures. Environmental sample analyses were provided by Intertek (formerly Inchcape) Testing Services of Richardson, Texas.

3.1 BOREHOLE LOCATIONS AND SAMPLING DEPTHS

Confirmatory soil sampling was conducted at the site on 8 through 10 December 1997. Six boreholes (CSB1 through CSB6) were advanced at the site, and soil samples were collected to confirm that hydrocarbon concentrations in soil have been remediated to acceptable levels. Figure 3.1 shows the locations of the six confirmatory soil sampling borehole locations. Samples for geologic logging, field total volatile hydrocarbon analyzer (TVHA) screening, and chemical analysis were collected at 5 to 7 feet bgs and 10 to 12 feet bgs at each borehole. These sampling locations were chosen because they represent the locations sampled during the bioventing system installation and the 1- and 2- year sampling events, with the exception of VW1 and VW2. These two locations were omitted because significant concentrations of TRPH and BTEX had not been detected there during previous sampling events.

3.2 DRILLING, SAMPLING, AND EQUIPMENT DECONTAMINATION

Boreholes were advanced and soil samples collected using a truck-mounted, hydraulically-powered Geoprobe® percussion/probing machine capable of advancing sampling tools through unconsolidated soils. The Geoprobe® system provides for the rapid collection of soil samples at shallow depths while minimizing the generation of investigation-derived waste (IDW) materials.

Prior to sampling, all downhole equipment and sampling tools were decontaminated as described in the SAP (Appendix A). Soil samples were collected using a probe-driven sampler. The probe-driven sampler served as both the driving point and the sample collection device and was attached to the leading end of the probe rods. To collect a soil sample, the sampler was pushed or driven to the desired sampling depth, the drive point was retracted to open the sampling barrel, and the sampler was

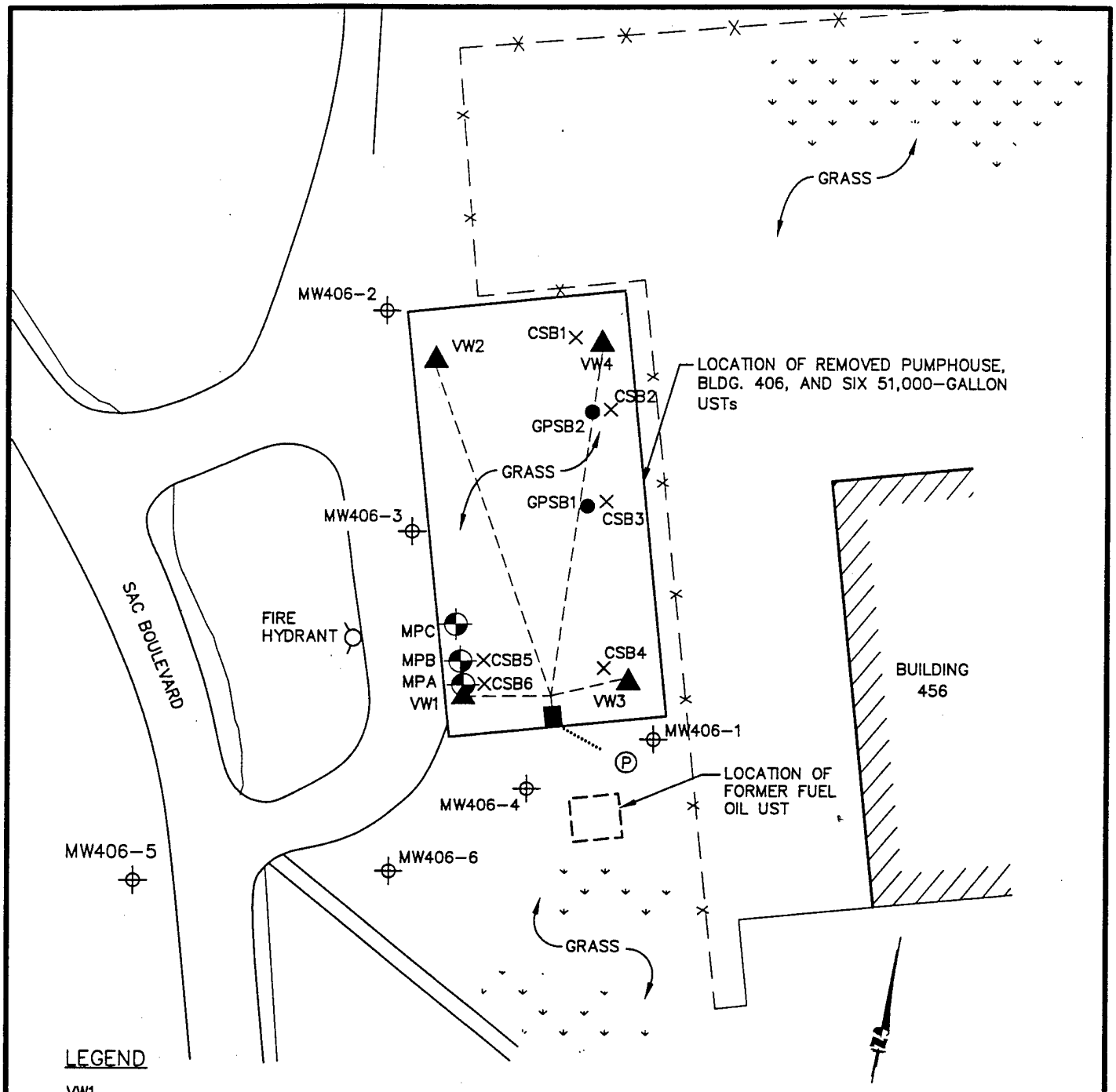

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FIGURE 3.1

CONFIRMATION SOIL SAMPLING LOCATIONS

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for Building 406 Site
Offutt Air Force Base, Nebraska

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subsequently pushed into the undisturbed soils. The soil cores were retained within clear acetate liners inside the sampling barrel. The probe rods were then retracted, bringing the sampling device with the collected soil sample to the surface. The soil sample was extruded from the liners for lithologic logging, or the liners were capped in the field so that the undisturbed samples could be submitted to the analytical laboratory for testing. All soil samples were screened with a TVHA.

Soil samples were collected from 5 to 7 and 10 to 12 feet bgs intervals from each borehole. The 2-feet long samples, including the acetate liners, were cut into 6-inch sections and the ends of each section were field screened using the TVHA. The most contaminated interval, based on field screening, was selected for laboratory analysis. The ends of the interval selected for analysis were capped with Teflon® sheets and plastic caps. A total of 12 confirmatory soil samples were collected at Building 406 and submitted for laboratory analysis of BTEX, TRPH, and polynuclear aromatic hydrocarbons (PAHs).

Soil samples selected for laboratory analysis were labeled with the site name, borehole number, sample depth, date of collection, and other pertinent data. Sample containers were then packaged and placed in an insulated shipping container packed with ice. Samples for laboratory analysis were shipped under standard chain-of-custody procedures to Intertek Testing Services in Richardson, Texas.

After sampling was completed, each borehole was backfilled with granular bentonite placed and hydrated in 3-feet lifts. The upper foot of each borehole was filled with excess soil sample.

Any remaining soil sample was then spread on the ground surface at the site. Wastewater generated at the site during decontamination of the sampling equipment was discharged onto the ground surface near each borehole.

3.3 FIELD AND LABORATORY DATA QUALITY ASSURANCE/QUALITY CONTROL

Samples were collected, preserved, transported, and analyzed in such a manner that analytical results generated on the collected samples would be technically sound, statistically valid, and properly documented. To meet this requirement, the procedures described in Section 4 of the SAP (Appendix A) were followed during sample collection, handling, and analysis. In addition, laboratory QC samples were prepared and analyzed. QC samples included a blind field duplicate (sample CSB7-5.5' was a duplicate of CSB1-5'), a trip blank, and excess soil sample from one location (CSB2-5') for use as a matrix spike/matrix spike duplicate (MS/MSD) sample.

3.4 SOIL ANALYSIS

All samples were analyzed by Intertek Testing Services. The sample analytical methods and reporting limits used during this effort are presented in Table 3.1. All soil samples were analyzed by USEPA Method SW8020 for BTEX, by USEPA Method 418.1 for TRPH, and by USEPA Method SW8310 for PAHs.

TABLE 3.1
ANALYTICAL METHODS AND REPORTING LIMITS
CONFIRMATION SAMPLING AND ANALYSIS REPORT
BUILDING 406 SITE
OFFUTT AFB, NEBRASKA

	Extraction Method	Analytical Method	Reporting Limit (mg/kg)[a/]
BTEX[b/]			
Benzene	SW5030	SW8020	0.0012
Toluene	SW5030	SW8020	0.0024
Ethylbenzene	SW5030	SW8020	0.0024
m,p-Xylenes	SW5030	SW8020	0.0024
o-Xylene	SW5030	SW8020	0.0024
TPH[c/]	E418.1	E418.1	30.6
PAHs[d/]			
Acenaphthene	SW3550	SW8310	1.47
Acenaphthylene	SW3550	SW8310	1.88
Anthracene	SW3550	SW8310	0.538
Benzo(a)anthracene	SW3550	SW8310	0.011
Benzo(a)pyrene	SW3550	SW8310	0.0183
Benzo(b)fluoranthene	SW3550	SW8310	0.0147
Benzo(g,h,i)perylene	SW3550	SW8310	0.0611
Benzo(k)fluoranthene	SW3550	SW8310	0.0134
Chrysene	SW3550	SW8310	0.122
Dibenzo(a,h)anthracene	SW3550	SW8310	0.0245
Fluoranthene	SW3550	SW8310	0.171
Fluorene	SW3550	SW8310	0.171
Ideno(1, 2, 3-c,d)pyrene	SW3550	SW8310	0.0367
Naphthalene	SW3550	SW8310	1.47
Phenanthrene	SW3550	SW8310	0.0513
Pyrene	SW3550	SW8310	0.22

[a/] mg/kg = milligrams per kilogram. The minimum practical quantitation limit is shown. Actual practical quantitation limits vary with moisture content and dilution factors.
[b/] BTEX = benzene, toluene, ethylbenzene, and xylenes.
[c/] TPH = Total petroleum hydrocarbons.
[d/] PAHs = Polynuclear aromatic hydrocarbons.

SECTION 4

CONFIRMATION SAMPLING RESULTS

The objective of the confirmation soil sampling was to demonstrate that there is not an unacceptable risk associated with residual petroleum hydrocarbons in vadose zone soils. This section summarizes the analytical results from confirmation soil sampling activities. This section also establishes ACLs for soils at this site using the ASTM tiered approach. First, Tier 1 RBSLs are developed and compounds that do not exceed these levels are eliminated from further consideration. Next, Tier 2 SSTLs are developed and compounds that do not exceed these levels are eliminated. Finally, a Tier 3 evaluation is performed for the remaining compounds to develop values for potential exposure pathways at the points of exposure based on site-specific conditions.

4.1 LABORATORY SOIL RESULTS

Soil analytical results are summarized in Table 4.1, and complete soil analytical results from Intertek Testing Services are presented in Appendix B. Soil sample analysis indicates that the highest concentrations of detected organic compounds were measured at VW3 at the sampling interval at 10 feet bgs.

The maximum detected concentrations of benzene, ethylbenzene, and xylenes were 4.42, 6.28, and 17.5 mg/kg, respectively. No toluene was detected in site soils during this sampling event. The highest detection of benzene (4.42 mg/kg) was in sample CSB7-5.5, which was a duplicate of CSB1-5 where no benzene was detected. This is likely the result of heterogeneous distribution of fuel hydrocarbons in the backfill soils. Benzene was only detected at two other locations at much lower concentrations (CSB3-5 at 0.0013 mg/kg and CSB3-10 at 0.06 mg/kg).

TPH was detected at a maximum concentration of 1,030 mg/kg at VW3 at the 10 feet bgs sampling interval. This result is significantly higher than any previous soil sampling results for TPH from this location, again suggesting a high degree of heterogeneity in the distribution of fuel hydrocarbons in site soils.

PAHs were detected in 7 of the 12 samples analyzed, with the maximum concentrations typically measured in the sample collected at VW3 at a depth of 10 feet bgs. Naphthalene was not detected in any of the soil samples; however, the reporting limit for naphthalene was 300 milligrams per kilogram (mg/kg) for the sample collected at VW3 at a depth of 10 feet bgs. The maximum detection of benzo(a)pyrene was 65.5 mg/kg in the soil sample collected at VW3 at a depth of 10 feet bgs.

TABLE 4.1
CONFIRMATORY SOIL SAMPLE ANALYTICAL RESULTS
CONFIRMATION SAMPLING AND ANALYSIS REPORT
BUILDING 406 SITE
OFFUTT AFB, NEBRASKA

Sample Identification	OF4-CSB1	OF4-CSB7	OF4-CSB1	OF4-CSB2	OF4-CSB2	OF4-CSB3	OF4-CSB3
Sampling Location	VW4	VW4	VW4	GPSB2	GPSB2	GPSB1	GPSB1
Depth Sampled (feet bgs[a/])	5	5.5	10	5	10	5	10
Date Sampled	12/8/97	12/8/97	12/8/97	12/9/97	12/9/97	12/9/97	12/9/97
Units	(mg/kg)[b/]	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Method SW8020							
Benzene	<0.31[c/]	4.42	<0.0013	<0.0012	<0.0013	0.0013	0.06 J[d/]
Toluene	<0.62	<0.25	<0.0026	<0.0024	<0.0026	<0.0024	<0.22
Ethylbenzene	<0.62	0.74	<0.0026	<0.0024	<0.0026	0.0445	2
m,p-Xylenes	12	<0.25	<0.0026	<0.0024	<0.0026	0.0566	5.64
o-Xylene	<0.62	<0.25	<0.0026	<0.0024	0.0013 J	<0.0024	<0.22
Method 418.1							
TPH[d/]	395	<31.3	<32.6	<30.6	<31.9	53.8	93.7
Method SW8310							
Acenaphthene	<14.8	<15	<15.7	<1.47	<1.53	0.915 J	<268
Acenaphthylene	<19	<19.3	<20.1	<1.88	<1.97	<9.27	<343
Anthracene	0.178 J	0.146 J	0.191 J	<0.538	<0.562	0.136 J	5.45 J
Benzo(a)anthracene	0.207	0.672	0.239	<0.011	<0.0115	0.295	10.8
Benzo(a)pyrene	0.297	1.14	0.211	<0.0183	<0.0191	0.453	17.7
Benzo(b)fluoranthene	0.202	0.991	0.134 J	<0.0147	<0.0153	0.39	14.9
Benzo(g,h,i)perylene	0.095 J	0.499 J	0.04 J	<0.0611	<0.0638	0.219 J	7.83 J
Benzo(k)fluoranthene	0.154	0.701	0.112 J	<0.0134	<0.014	0.281	9.76
Chrysene	0.791 J	1.43	2.22	<0.122	<0.128	0.467 J	14.3 J
Dibenzo(a,h)anthracene	<0.247	0.314	<0.261	<0.0245	<0.0255	0.169	5.84
Fluoranthene	1.76	2.19	1.92	<0.171	<0.179	1.14	48.8
Fluorene	0.152 J	<1.75	<1.83	<0.171	<0.179	0.179 J	4.71 J
Indeno(1,2,3-c,d)pyrene	0.099 J	0.428	0.033 J	<0.0367	<0.0383	0.206	7.75
Naphthalene	<14.8	<15	<15.7	<1.47	<1.53	<7.22	<268
Phenanthrene	0.834	0.563	0.534 J	<0.0513	<0.0536	0.572	21.5
Pyrene	0.511 J	2.26	1.93 J	<0.22	<0.23	1.13	48.4

TABLE 4.1 (Concluded)
CONFIRMATORY SOIL SAMPLE ANALYTICAL RESULTS
CONFIRMATION SAMPLING AND ANALYSIS REPORT
BUILDING 406 SITE
OFFUTT AFB, NEBRASKA

Sample Identification	OF4-CSB4	OF4-CSB4	OF4-CSB5	OF4-CSB5	OF4-CSB6	OF4-CSB6
Sampling Location	VW3	VW3	MPB	MPB	MPA	MPA
Depth Sampled (feet bgs)	5	10	6	10	6	11
Date Sampled	12/9/97	12/9/97	12/8/97	12/8/97	12/8/97	12/8/97
Units	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Method SW8020						
Benzene	<0.31	<0.63	<0.0013	<0.0013	<0.0012	<0.0013
Toluene	<0.62	<1.25	<0.0026	<0.0026	<0.0025	<0.0026
Ethylbenzene	6.28	5.29	<0.0026	<0.0026	<0.0025	<0.0026
m,p-Xylenes	<0.62	17.5	<0.0026	<0.0026	<0.0025	<0.0026
o-Xylene	<0.62	<1.25	<0.0026	<0.0026	<0.0025	<0.0026
Method 418.1						
TPH	181	1030	<32.3	<33	130	<32
Method SW8310						
Acenaphthene	<29.9	<300	<1.55	<1.59	<1.5	<1.54
Acenaphthylene	<38.3	<385	<1.99	<2.03	<1.92	<1.97
Anthracene	0.504 J	7.66 J	<0.568	<0.581	<0.55	<0.564
Benzo(a)anthracene	0.764	31	<0.0116	<0.0119	<0.0112	<0.0115
Benzo(a)pyrene	0.92	65.5	<0.0194	<0.0198	0.0027 J	<0.0192
Benzo(b)fluoranthene	0.682	51.1	<0.0155	<0.0159	0.0047 J	<0.0154
Benzo(g,h,i)perylene	0.258 J	27.5	<0.0646	<0.0661	0.0028 J	<0.0641
Benzo(k)fluoranthene	0.428	32	<0.0142	<0.0145	<0.0137	<0.0141
Chrysene	1.47 J	51.4	<0.129	<0.132	<0.125	<0.128
Dibenzo(a,h)anthracene	0.184 J	20.4	<0.0258	<0.0264	<0.025	<0.0256
Fluoranthene	4.78	53.1	<0.181	<0.185	0.0123 J	<0.179
Fluorene	0.337 J	<35	<0.181	<0.185	<0.175	<0.179
Indeno(1,2,3-c,d)pyrene	0.259 J	25.5	<0.0388	<0.0396	<0.0375	<0.0384
Naphthalene	<29.9	<300	<1.55	<1.59	<1.5	<1.54
Phenanthrene	2.05	18.3	<0.0543	<0.0555	<0.0525	<0.0538
Pyrene	4.59	57.5	<0.233	<0.238	0.0901 J	<0.231

[a] bgs = below ground surface.

[b] mg/kg = milligrams per kilogram.

[c] < = compound analyzed for, but not detected. Number shown represents the reporting limit..

[d] J = compound detected at concentration less than reporting limit but greater than method detection limit, result is estimated.

[e] TPH = total petroleum hydrocarbons.

Table 4.2 compares the results of the December 1997 (4-year/confirmatory) sampling event with results from earlier sampling events. The results indicate that TPH concentrations have decreased at most sampling locations over the treatment period. Similarly, BTEX concentrations have been reduced to non-detect or very low concentrations.

4.2 DEVELOPMENT OF SOIL CLEANUP GOALS

The NDEQ determines final soil and groundwater cleanup levels on a case-by-case basis depending on site conditions. Cleanup standards generally are dependent on the beneficial use classification of the aquifer impacted or potentially impacted by soil petroleum hydrocarbon contamination. A remedial action class (RAC) is defined for pollution occurrences in three types of groundwater (or overlying soils) depending on the degree (or potential) of use of the groundwater as a drinking water. The extent of remedial action required differs depending on the RAC of the contaminated (or likely to be contaminated) groundwater.

The Building 406 site has been classified as a RAC-3 occurrence. RAC-3 includes, but is not limited to, petroleum contamination of groundwater not used, and unlikely to be used, as drinking water. Factors that may result in a RAC-3 classification include: poor natural quality of the groundwater, thus making it unfit for human consumption; poor aquifer yields; and past and present intensive land use including areas of high industrial development or densely populated areas where groundwater is likely to be contaminated or will not be used as drinking water (NDEQ, 1991).

Typically, the only required remedial action for a RAC-3 occurrence is removal of readily removable contaminants (e.g., free product). However, because contaminated soils were returned to the excavation following removal of the USTs, the NDEQ requested remedial action for these soils. Specific soil cleanup levels have not been defined for this site and further groundwater investigation has not been requested by the NDEQ.

The ASTM has developed the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites,* a tiered, RBCA approach for defining cleanup requirements at petroleum-hydrocarbon-contaminated sites (ASTM, 1995). The tiered, or iterative, approach allows first for screening of contaminant concentrations against generic risk-based concentrations, followed by the development of site-specific cleanup criteria based on an analysis of site data and receptors that could potentially be exposed to chemical contamination at or downgradient from the release site. The overall objective of the ASTM RBCA approach is to identify site environmental media that does not pose an unacceptable risk to current or potential future receptors. If no risk exists there is no need for further evaluation or remediation and the site may be eligible for closure. As described in the SAP (Parsons ES, 1997b), the ASTM RBCA standard will be used for developing final soil cleanup standards for the Building 406 Site. Because RBCA criteria are based on current or foreseeable land uses and human receptor exposure scenarios, a review of available land use information is provided below.

TABLE 4.2
INITIAL, 1-YEAR, 2-YEAR and 4-YEAR SOIL ANALYTICAL RESULTS
CONFIRMATION SAMPLING AND ANALYSIS REPORT
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

Analyte (Units) [a]	Sample Locations-Depth (in feet below ground surface)											
	VW1-5				VW1-10				MPA-5			
Soil Hydrocarbons	Initial [b]	1-Year [c]	2-Year [d] [e]	4-Year [f]	Initial	1-Year	2-Year [e]	4-Year	Initial	1-Year	2-Year	4-Year
TRPH (mg/kg)	<8.0	<12.5	<50/<50	NA	<6.5	<12.5	<50/<50	NA[g]	6,060	6,070	1,300	130
Benzene (mg/kg)	<0.0020	<0.061	<0.10/<0.10	NA	0.0073	<0.063	<0.10/<0.10	NA	20	<0.061	<0.10	<0.0012
Toluene (mg/kg)	<0.0020	<0.061	<0.10/<0.10	NA	0.0007	<0.063	<0.10/<0.10	NA	<5	1.9	<0.10	<0.0025
Ethylbenzene (mg/kg)	<0.0020	<0.061	<0.10/<0.10	NA	0.0044	<0.063	<0.10/<0.10	NA	270	<0.061	<0.10	<0.0025
Xylenes (mg/kg)	<0.0020	<0.12	<0.20/<0.20	NA	0.007	<0.13	<0.20/<0.20	NA	380	7.5	<0.20	<0.0050
Moisture (%)	NS[h]	20.5	21.7/22.2	NA	23	21.6	24.2/22.8	NA	NS	19.5	22.0	

	MPA-10				MPB-5				MPB-10			
Soil Hydrocarbons	Initial	1-Year	2-Year	4-Year	Initial [b]	1-Year [c]	2-Year [d]	4-Year	Initial	1-Year	2-Year	4-Year
TRPH (mg/kg)	2,820	5,000	<50	<32	2,780	2,270	<50	<32.3	110	223	<50	<33
Benzene (mg/kg)	7.4	<0.056	<0.10	<0.0013	<1.0	<0.062	<0.10	<0.0013	1.2	<0.062	<0.10	<0.0013
Toluene (mg/kg)	5	5.5	<0.10	<0.0026	<1.0	0.71	<0.10	<0.0026	0.58	<0.062	<0.10	<0.0026
Ethylbenzene (mg/kg)	78	<0.056	<0.10	<0.0026	43	<0.062	<0.10	<0.0026	4.7	<0.062	<0.10	<0.0026
Xylenes (mg/kg)	130	14	<0.20	<0.0052	49	0.51	<0.20	<0.0052	10	<0.12	<0.20	<0.0052
Moisture (%)	23	11.5	23.9		NS	20.4	21.3		22	20.7	22.9	

	VW2-5				VW2-10				VW3-5			
Soil Hydrocarbons	Initial	1-Year	2-Year	4-Year	Initial	1-Year	2-Year	4-Year	Initial [b]	1-Year [c]	2-Year [d]	4-Year
TRPH (mg/kg)	<8.0	<12.3	<50	NA	<6.6	<12.9	<50	NA	1,300	11,700	<50	181
Benzene (mg/kg)	<0.0020	<0.062	<0.10	NA	<0.0006	<0.064	<0.10	NA	<0.25	<0.062	<0.10	<0.31
Toluene (mg/kg)	<0.0020	<0.062	<0.10	NA	0.0049	<0.064	<0.10	NA	<0.25	0.97	<0.10	<0.62
Ethylbenzene (mg/kg)	<0.0020	<0.062	<0.10	NA	<0.0006	<0.064	<0.10	NA	12	<0.062	0.16	6.28
Xylenes (mg/kg)	<0.0020	<0.12	<0.20	NA	0.0052	<0.13	<0.20	NA	14	1.2	<0.20	<1.24
Moisture (%)	NS	19.5	20.9	NA	24	22.2	23.9	NA	NS	18.7	4.0	

TABLE 4.2 (CONCLUDED)
INITIAL, 1-YEAR, 2-YEAR and 4-YEAR SOIL ANALYTICAL RESULTS
CONFIRMATION SAMPLING AND ANALYSIS REPORT
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

Sample Locations-Depth (in feet below ground surface)

Analyte (Units) [a/]	VW3-10				VW4-5				VW4-10			
Soil Hydrocarbons	Initial	1-Year	2-Year	4-Year	Initial	1-Year	2-Year	4-Year	Initial	1-Year	2-Year	4-Year
TRPH (mg/kg)	94	19.3	390	1030	600	30.3	<50	395/<31.3	<6.5	<12.9	<50	<32.6
Benzene (mg/kg)	3.6	0.17	1.3	<0.63	<0.50	<0.062	<0.10	<0.31/4.42	<0.16	<0.064	<0.10	<0.0013
Toluene (mg/kg)	<3.1	0.13	<0.50	<1.25	1.1	<0.062	<0.10	<0.62/<0.25	8.8	<0.064	<0.10	<0.0026
Ethylbenzene (mg/kg)	8.6	<0.062	28	5.29	<0.50	<0.062	<0.10	<0.62/0.74	0.52	<0.064	<0.10	<0.0026
Xylenes (mg/kg)	22	0.17	48	17.5	1.2	<0.12	<0.20	12/<0.5	2.5	<0.13	<0.20	<0.0052
Moisture (%)	20	20.1	18.2		NS	20.3	21.1		23	22.5	21.4	

Soil Hydrocarbons	GPSB1-5				GPSB1-10				GPSB2-5			
	Initial [b/]	1-Year [c/]	2-Year [d/]	4-Year	Initial	1-Year	2-Year	4-Year	Initial	1-Year	2-Year	4-Year
TRPH (mg/kg)	NS	724	<50	53.8	NS	66	430	93.7	NS	1,150	100	<30.6
Benzene (mg/kg)	NS	<0.063	<0.20	0.0013	NS	0.097	<0.50	0.06	NS	<0.058	<0.10	<0.0012
Toluene (mg/kg)	NS	0.80	<0.20	<0.0024	NS	1.6	<0.50	<0.22	NS	1.3	0.13	<0.0024
Ethylbenzene (mg/kg)	NS	<0.063	5.2	0.0445	NS	<0.063	8.1	2	NS	0.089	2.8	<0.0024
Xylenes (mg/kg)	NS	0.63	3.5	0.0566	NS	0.280	4.0	5.64	NS	1.2	1.9	<0.0048
Moisture (%)	NS	21.2	20.4		NS	20.9	20.4		NS	18.4	16.0	

Soil Hydrocarbons	GPSB2-10			
	Initial	1-Year	2-Year	4-Year
TRPH (mg/kg)	NS	35.8	<50	<31.9
Benzene (mg/kg)	NS	0.11	0.13	<0.0013
Toluene (mg/kg)	NS	1.3	<0.10	<0.0026
Ethylbenzene (mg/kg)	NS	<0.064	0.71	<0.0026
Xylenes (mg/kg)	NS	3.9	1.1	0.0013
Moisture (%)	NS	22.3	19.1	

[a/] mg/kg = milligrams per kilogram.
[b/] Initial soil samples collected on 20-22 October 1993.
[c/] 1-Year soil samples collected on 11-12 October 1994.
[d/] 2-Year soil samples collected on 28-29 September 1995.
[e/] Primary sample result/replicate sample result.
[f/] 4-Year soil samples collected on 8 and 9 December 1997.
[g/] NA = Not analyzed.
[h/] NS = Not sampled.

4.2.1 Land Use and Potential Receptors

Offutt AFB is an active facility and is not scheduled for closure. Current land use for the Building 406 site and adjacent land is industrial, and future land use for the site is likely to be industrial. Current and future onsite workers are likely to represent the primary human receptor population. Because of the developed nature of the site and surrounding areas, ecological receptors are not likely to be exposed to contaminants in site media under current or anticipated future land uses.

Groundwater within Offutt AFB property is not currently used as a potable water source. As a result, exposure of onsite and off-site human receptors to site contaminants through ingestion of, inhalation of, or dermal contact with contaminants in groundwater extracted for potable use is unlikely. More likely exposure pathways include soil volatilization to outdoor air, soil-vapor intrusion into buildings, and ingestion, dermal contact, or inhalation of surficial soil. Because the area is grass covered and surface soils are not known to be impacted by jet fuel, ingestion is not a likely chronic exposure pathway. Construction activities in the area could result in acute exposure to fuel hydrocarbons but is not anticipated in this area. Volatilization of fuel hydrocarbons from soil and vapor migration into onsite or off-site structures is expected to be the most significant exposure pathway resulting from contamination at the Building 406 site. This exposure pathway generally results in the lowest screening levels and therefore is the most conservative of the potential exposure pathways.

4.2.2 Cleanup Goals

Under Tier 1 of the ASTM RBCA standard (ASTM, 1995), RBSLs are developed as the first step and then compared to site contaminant concentrations. The RBSLs are not intended as final cleanup goals but serve as conservative values to compare site contaminant concentrations against. If site contaminant concentrations are less than the RBSLs then the RBCA standard suggests no further corrective action is required to protect potential receptors. If site contaminant concentrations exceed the RBSLs, then site specific target levels (SSTLs) are developed through a Tier 2 evaluation. In the Tier 2 evaluation, the non-site-specific assumptions and points of exposure used in the Tier 1 evaluation are replaced with site-specific data to calculate the SSTLs. If site contaminant concentrations exceed the Tier 2 SSTLs, a Tier 3 evaluation can be performed to develop values for potential exposure pathways at the points of exposure based on site-specific conditions.

As recommended in the ASTM (1995) RBCA guidance, TPH data should not be used for risk assessment because the general measure of TPH provides insufficient information about concentrations of individual chemicals. Consequently, TPH laboratory results were not compared to RBSLs or SSTLs.

As shown in Table 4.1, several PAHs were detected in site soils. PAHs generally have low solubility, high affinity for sorbing to soil, and low volatility. Because most biodegradation mechanisms require hydrocarbons to be present in the soil-water fraction, these properties limit the bioavailability of PAHs. These properties also

minimize the potential for PAHs to migrate from soil and impact other media such as groundwater, soil gas, and ambient air. Guidance from USEPA Region 9 states that PAHs with molecular weight greater than 200 grams per mole or a Henry's Law coefficient less than $1x10^{-5}$ atmospheres meters cubed per mole (atm-m^3/mol) are not volatile enough to be considered in exposure scenarios involving inhalation (Smucker, 1996). Therefore, all PAHs with a molecular weight greater than 200 grams per mole or a Henry's Law coefficient less than $1x10^{-5}$ atm-m^3/mol will not be considered in the soil-volatilization-to-indoor air pathway selected as the most likely exposure pathway for this site. Table 4.3 presents the molecular weights and Henry's Law coefficients for the compounds that were analyzed for in soil at the Building 406 site. No other exposure pathways are considered reasonable for PAHs.

4.3 COMPARISON OF CONFIRMATION SAMPLING RESULTS TO ACLS

After eliminating low volatility PAHs, 10 compounds (counting each xylene isomer as a different compound) remain for evaluation using the ASTM approach, including all the BTEX compounds. The algorithms and default parameters presented in the ASTM RBCA guidance were used along with chemical-specific properties to develop Tier 1 RBSLs for these chemicals. The default parameters used to calculate the Tier 1 RBSLs are presented in Table 4.4. Table 4.5 presents these RBSLs and compares them to the maximum detected concentrations from the December 1997 confirmation soil sampling event. If the maximum site contaminant concentration does not exceed its most stringent RBSL, the compound will not be considered a chemical of potential concern (COPC), and will not be retained for further Tier 2 evaluation. Under these circumstances, no additional remediation would be warranted for such compounds in order to protect human receptors. If a detected site contaminant exceeds the appropriate RBSL, the compound is identified as a COPC and retained for further evaluation.

Inhalation toxicity values (slope factors and reference doses) are only available for BTEX and naphthalene. Therefore, oral toxicity values were substituted where no inhalation values were available. The resulting RBSLs for the compounds without inhalation toxicity values were at least four orders of magnitude greater than the maximum detected concentrations at the Building 406 site. In addition, the RBSLs for all PAHs with the exception of naphthalene were greater than their saturation concentrations. At soil concentrations greater than saturation concentrations, soil vapor and indoor air concentrations reach a maximum and do not increase as the soil concentrations increase. In these cases, the selected risk level is not exceeded for pure compound present at any concentration. No inhalation or oral toxicity data are available for acenaphthylene or phenanthrene, so RBSLs could not be developed. As shown in Table 4.5, only the maximum detections of benzene and naphthalene exceeded their respective RBSLs. Therefore, all other compounds were removed from further evaluation and only benzene and naphthalene were evaluated in Tier 2.

For the Tier 2 evaluation, several conservative generic assumptions used to calculate the RBSLs were changed to site-specific values to develop SSTLs. The site specific values are provided in Table 4.4. The parameters changed to site-specific values

TABLE 4.3
CHEMICAL PROPERTIES RELEVANT FOR AIR EXPOSURE PATHWAY
CONFIRMATION SAMPLING AND ANALYSIS REPORT
BUILDING 406 SITE
OFFUTT AFB, NEBRASKA

	Molecular Weight (grams/mole)	H (atm-m^3/mol)[a/]	Retain for Soil to Indoor Air Pathway?
Volatiles			
Benzene[b/]	78	5.56E-03	Yes
Toluene[c/]	92	6.34E-03	Yes
Ethylbenzene[b/]	106	7.88E-03	Yes
m,p-Xylenes[c/]	106	7.07E-03	Yes
o-Xylene[c/]	106	7.07E-03	Yes
PAHs[d/]			
Acenaphthene[b/]	154	1.55E-04	Yes
Acenaphthylene[c/]	152	2.80E-04	No[e/]
Anthracene[b/]	178	6.51E-05	Yes
Benzo(a)anthracene[b/]	228	3.34E-06	No
Benzo(a)pyrene[b/]	252	1.13E-06	No
Benzo(b)fluoranthene[b/]	252	1.11E-04	No
Benzo(g,h,i)perylene[c/]	276	1.40E-07	No
Benzo(k)fluoranthene[b/]	252	8.29E-07	No
Chrysene[b/]	228	9.46E-05	No
Dibenzo(a,h)anthracene[b/]	278	1.47E-08	No
Fluoranthene[b/]	202	1.61E-05	No
Fluorene[b/]	166	6.37E-05	Yes
Ideno(1, 2, 3-c, d)pyrene[b/]	276	1.61E-05	No
Naphthalene[c/]	128	1.20E-03	Yes
Phenanthrene[c/]	178	3.90E-05	No
Pyrene[c/]	202	1.09E-05	No

[a/] H = Henry's Law constant in atmospheres cubic meter per mole (20-25° Celsius).

[b/] USEPA, 1996.

[c/] Montgomery, 1996.

[d/] PAHs = Polynuclear aromatic hydrocarbons.

[e/] Compound not retained because no toxicity data for the inhalation exposure route are available.

TABLE 4.4
GENERIC AND SITE-SPECIFIC VALUES USED IN CALCULATING ALTERNATIVE COMPLIANCE LIMITS
CONFIRMATION SAMPLING AND ANALYSIS REPORT
BUILDING 406 SITE
OFFUTT AFB, NEBRASKA

Parameter	Definition	Units	Parameters used to calculate ACLs[a/] for indoor air inhalation exposure pathway for commercial/industrial land use: Generic assumptions for Tier 1 RBSLs[b/]	Site-specific assumptions for Tier 2 SSTLs[c/]
ER	Enclosed space air exchange rate	1/second	0.0002	0.0002
f_{oc}	Soil organic carbon fraction	gram/gram	0.01	0.01
h_{cap}	Capillary fringe thickness	cm[d/]	5	15 [c/]
h_v	Vadose zone thickness	cm	295	490
L_b	Enclosed space volume/infiltration area ratio	cm^3/cm^2	300	300
L_{crack}	Enclosed space foundation thickness	cm	15	15
L_{gw}	Depth to groundwater = $h_{cap} + h_v$	cm	300	505
L_s	Depth to subsurface soil sources	cm	100	180
η	Areal fraction of cracks in foundation	cm^2/cm^2	0.01	0.01
θ_{acrack}	Volumetric air content in foundation cracks	cm^3/cm^3	0.26	0.26
θ_{as}	Volumetric air content in vadose zone soils	cm^3/cm^3	0.26	0.12
θ_T	Total soil porosity	cm^3/cm^3	0.38	0.45
θ_{wcrack}	Volumetric water content in foundation cracks	cm^3/cm^3	0.12	0.12
θ_{ws}	Volumetric water content in vadose zone soils	cm^3/cm^3	0.12	0.33
ρ_s	Soil bulk density	$gram/cm^3$	1.7	1.46

[a/] ACLs = Alternative compliance limits

[b/] RBSLs = Risk based screening levels.

[c/] SSTLs = Site specific target levels.

[d/] cm = centimeters.

[e/] Shading indicates site-specific assumptions that differ from ASTM generic assumptions.

TABLE 4.5
COMPARISON OF MAXIMUM RESIDUAL SOIL CONCENTRATIONS TO TIER 1 RISK-BASED SCREENING LEVELS
CONFIRMATION SAMPLING AND ANALYSIS REPORT
BUILDING 406 SITE
OFFUTT AFB, NEBRASKA

	Units	ASTM Comm/Indus Vapor Intrusion[a/]	Maximum Confirmation Sampling Result	Max. Conc. Exceeds Listed Criterion?
Volatiles				
Benzene	mg/kg[b/]	0.016	4.42	Yes
Toluene	mg/kg	52.5	<1.25 [c/]	No
Ethylbenzene	mg/kg	91.8	6.28	No
m,p-Xylenes	mg/kg	RES[d/]	17.5	No
o-Xylene	mg/kg	RES	<1.25	No
PAHs				
Acenaphthene	mg/kg	RES	<300	No
Anthracene	mg/kg	RES	7.66 J[e/]	No
Fluorene	mg/kg	RES	<35 J	No
Naphthalene	mg/kg	107	<300	Yes

[a/] Values shown represent Tier 1 Risk-Based Screening Levels (RBSLs) for commercial/industrial receptor scenario considering soil-vapor intrusion from soil into buildings (ASTM, 1995).

[b/] mg/kg = millirams per kilogram.

[c/] < = analyte concentration less than laboratory reporting limit shown.

[d/] RES = Selected risk level is not exceeded for pure compound present at any concentration (ASTM, 1995).

[e/] J = Compound detected above method detection limit and less than reporting limit. Reported concentration is a laboratory estimate.

included the depth of the vadose zone, depth to contaminated soils, width of contaminated soils, soil porosity, and bulk density. Table 4.6 presents the SSTLs for benzene and naphthalene. Using site-specific parameters in the algorithms, the resulting SSTLs are about 4 to 5 times greater than the comparable RBSLs. However, the maximum detected benzene concentration (4.42 mg/kg) still exceeds the SSTL (0.0757 mg/kg).

Because benzene exceeded the Tier 2 SSTL, it was determined that a Tier 3 evaluation for benzene was warranted. A fate and transport model that estimates indoor air concentrations based on contributions from residual soil contamination, groundwater, and free product was utilized. The model inputs were set to reflect that no benzene was detected in groundwater and free product is not present at the Building 406 site. Where applicable, the same site-specific parameters were input as were used in the Tier 2 analysis. It was assumed that only 10 air exchanges per day occur in the building and the benzene diffusing into the building only mixes with air in the lower story of the building. The area of Building 406 was used for the model but it was assumed that the building was directly above the former location of the tanks. The indoor air concentration of benzene estimated using the model is 3.06×10^{-2} micrograms per cubic meter ($\mu g/m^3$). This concentration is well below the ASTM RBSL of 4.93×10^{-1} $\mu g/L$ and the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 3.25×10^{3} $\mu g/m^3$ (1 ppmv).

TABLE 4.6
COMPARISON OF MAXIMUM RESIDUAL SOIL CONCENTRATIONS TO TIER 2 SITE-SPECIFIC TARGET LEVELS
CONFIRMATION SAMPLING AND ANALYSIS REPORT
BUILDING 406 SITE
OFFUTT AFB, NEBRASKA

Compound	Units	Tier 2 Commercial/ Industrial Vapor Intrusion[a/]	Maximum Confirmation Sampling Result	Maximum Concentration Exceeds Listed Criterion?
Benzene	mg/kg[b/]	0.0757	4.42	Yes
Naphthalene	mg/kg	395	<300[c/]	No

[a/] Values shown represent example Tier 2 Site-Specific Target Levels for commercial/industrial receptor scenario considering soil-vapor intrusion from soil into buildings (ASTM, 1995)

[b/] mg/kg = millirams per kilogram.

[c/] < = analyte concentration less than laboratory reporting limit shown.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Four years of bioventing treatment of vadose zone soils at Building 406 have successfully reduced the concentrations of BTEX and PAH compounds to concentrations below the risk-based ACLs developed to be health protective for this site. Although some BTEX and PAHs remain in site soils, the concentrations do not pose a threat to human health under any reasonable exposure scenario. The detection of benzene in CSB7-5.5 (duplicate sample collected at CSB1-5.5) exceeded the Tier 1 RBSL and the Tier 2 SSTL for the volatilization-to-indoor air pathway. However, the concentration of benzene at this location represents the highest concentration detected at the site during the December 1997 sampling. The next highest concentration of benzene detected was two orders of magnitude lower. In addition, no benzene was detected in the primary sample (CSB1-5) for which CSB7-6 was a duplicate. Therefore, using the benzene concentration from CSB7-6 for comparison to ACLs is extremely conservative. Likewise, using the benzene concentration from CSB7-6 in the Tier 3 evaluation assumes all impacted soil has a benzene concentration of 4.42 mg/kg and provides a worst-case indoor air concentration. Still, even under this assumption, the Tier 3 analysis showed that benzene concentrations remaining in site soils no longer pose a threat to reasonable human receptors through volatilization into future onsite buildings (or offsite structures).

5.2 RECOMMENDATIONS

The confirmatory soil sampling results presented in Section 4.1 and the previous groundwater investigation support an Air Force no-further-response-action-planned (NFRAP) decision for soil and groundwater impacted by jet fuel at and downgradient from the Building 406 site. Based on the confirmatory soil sample analytical results summarized in Table 4.1, site closure with no further remedial action at Building 406 is recommended. This site meets the risk-based ACLs for total BTEX and PAH compounds, and remaining fuel hydrocarbons in the soils and groundwater do not and will not present a significant risk to human health at or downgradient from the site. Additionally, the bioventing system at Building 406 has been in operation since confirmation sampling conducted in December 1997, thereby further reducing residual fuel contamination remaining in vadose zone soils.

Once closure of Building 406 has been approved by the NDEQ, it is recommended that the bioventing system be dismantled and removed from the site, and that the VW, MPs, and groundwater monitoring wells be properly abandoned.

SECTION 6

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FINAL
CONFIRMATION SAMPLING AND ANALYSIS PLAN
FOR BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

October 1997

Prepared for:

Air Force Center for Environmental Excellence
Brooks AFB, Texas
and

Headquarters 55th Air Combat Command (ACC)
Offutt AFB, Nebraska

Prepared by:
Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
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APPENDIX A
CONFIRMATION SAMPLING AND ANALYSIS PLAN

FINAL

Confirmation Sampling and Analysis Plan for Building 406

Offutt Air Force Base
Nebraska

Prepared For

Air Force Center for Environmental Excellence
Brooks Air Force Base, Texas

and

55 CES/CEVR
Headquarters Air Combat Command (ACC)
Offutt AFB, Nebraska

October 1997

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LIST OF ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Environmental Excellence
AFB	Air Force base
ASTM	American Society for Testing and Materials
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CES/CEVR	Civil Engineering Squadron/Environmental Division
COPC	chemical of potential concern
ES	Engineering-Science, Inc.
IDW	investigation-derived waste
JP-4	jet propulsion grade 4 [fuel]
MCL	maximum contaminant limit
µg/L	micrograms per liter
mg/kg	milligram(s) per kilogram
mg/L	milligrams per liter
MP	monitoring point
NDEQ	Nebraska Department of Environmental Quality
NFRAP	no further response action planned
PAH	polynuclear aromatic hydrocarbon
Parsons ES	Parsons Engineering Science, Inc.
PID	photoionization detector
ppmv	parts per million, volume per volume
QA	quality assurance
QC	quality control
RAC	Remedial Action Class
RBCA	risk-based corrective action
RBSL	risk-based screening level
SAC	Strategic Air Command
SAP	Sampling and Analysis Plan
SSL	soil screening level
TRPH	total recoverable petroleum hydrocarbon

TVH	total volatile hydrocarbons
TVHA	total volatile hydrocarbon analyzer
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
VW	vent well
yr	year

SECTION 1

INTRODUCTION

This confirmation sampling and analysis plan (SAP) has been prepared by Parsons Engineering Science, Inc. (Parsons ES), [formerly Engineering-Science, Inc. (ES)], for submittal to the US Air Force Center for Environmental Excellence (AFCEE), Brooks Air Force Base (AFB), Texas, and 55 Civil Engineering Squadron/Environmental Division (CES/CEVR), Offutt AFB, Nebraska. The SAP is intended to guide confirmation soil sampling at Building 406 at Offutt AFB, Nebraska. Building 406 is the location of a release of jet propulsion grade 4 (JP-4) jet fuel from a former underground storage tank (UST) system.

Since 1992, Offutt AFB has participated in two AFCEE-sponsored bioventing projects; currently, the Extended Bioventing Project, and formerly, the Bioventing Pilot Test Initiative. The Bioventing Pilot Test Initiative included conducting more than 135 *in situ* bioventing pilot tests at 48 Air Force installations nationwide. These tests were designed to collect data on the effectiveness of bioventing for the remediation of soil contaminated with fuel hydrocarbons (e.g., JP-4 jet fuel, diesel fuel, gasoline, or heating oil). As part of this project, bioventing pilot tests were conducted at the Low-Point Drain site (Building 528), Building 30, the Petroleum, Oils, and Lubricants site, and Building 406 at Offutt AFB.

The purpose of the pilot test at Building 406 was to evaluate the effectiveness of bioventing in remediating unsaturated soils contaminated with petroleum hydrocarbons that resulted from JP-4 released from the former USTs. The underground storage tanks (USTs) were removed in October 1993 (Terracon Environmental, Inc., 1993). Based on the results of the extended bioventing test, *in situ* bioventing appears to have reduced petroleum hydrocarbon contamination in site soils sufficiently to meet Nebraska Department of Environmental Quality (NDEQ) requirements for closure of the site. This SAP presents a plan for confirmation soil sampling to document the effectiveness of remediation of hydrocarbon contaminated soils at the Building 406 site.

The objective of the confirmatory soil sampling is to support an Air Force no-further-response-action-planned (NFRAP) decisions for the soils and groundwater impacted by JP-4 in the immediate vicinity of the former USTs, pursuant to closure of the Building 406 site. The confirmatory soil sampling effort is being performed as part of the AFCEE Extended Bioventing project.

This SAP consists of 10 sections, including this introduction. Section 2 includes site description, history, and summaries of previous investigations and remediation activities. Section 3 summarizes site closure requirements. A detailed sampling and

analysis strategy is presented in Section 4. Analytical results will be presented in a confirmation soil sampling report, as described in Section 5. Section 6 is a waste management plan for investigation-derived waste generated during drilling and sampling activities. Section 7 lists Offutt AFB support requirements, and Section 8 presents the proposed project schedule. Points of contact are provided in Section 9, and the references cited are provided in Section 10.

SECTION 2

SITE DESCRIPTION

Offutt AFB is located immediately south of Bellevue, Nebraska, approximately 10 miles south of Omaha. In 1896, Fort Crook was established at the location of the Base and became Offutt Field in 1924. In January 1948, Offutt Field was transferred to the Department of the Air Force and became Offutt AFB. The Base was the Strategic Air Command (Strategic Air Command) Headquarters from 1948 until 1992, when it became the 55th Wing of the Air Combat Command.

2.1 SITE LOCATION AND HISTORY

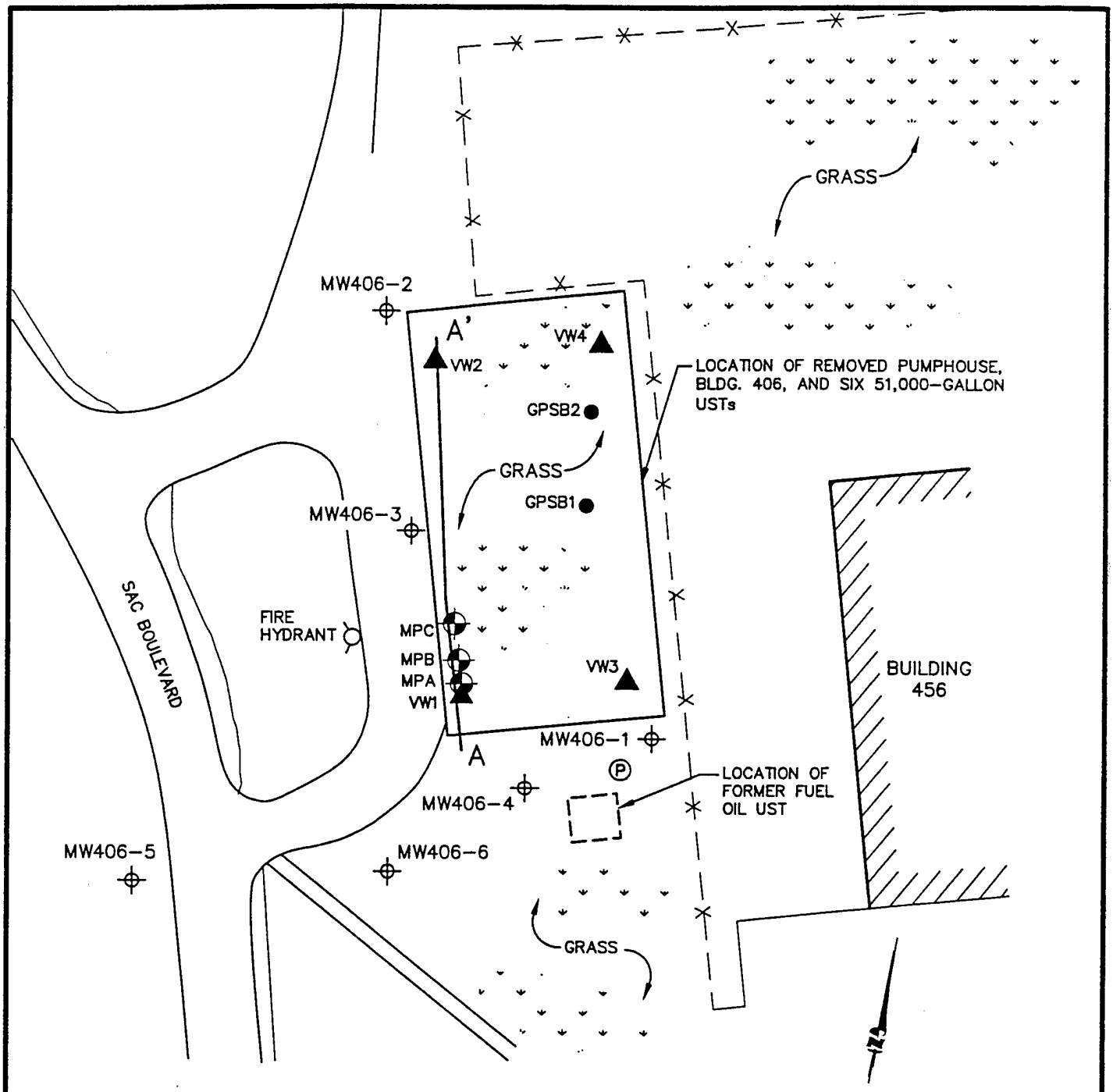
Building 406 was a fuel pumphouse serving six large USTs, located just east of SAC Boulevard at the northeastern corner of the Base golf course. A layout of the Building 406 site is shown on Figure 2.1. Each of the six USTs at the site was reported to be 60 feet long and 12 feet in diameter with a capacity of 51,000 gallons. One of these tanks contained deicing fluid and the others contained JP-4 and (formerly) AVGAS. A seventh UST, located to the south (Figure 2.1) was reported to have contained fuel oil. This tank was 6 feet long, 4 feet in diameter, and had a capacity of 560 gallons (Terracon Environmental, Inc., 1993). The fuel pumphouse and associated tanks were taken out of service in March 1992.

Contaminated soil was observed during removal of the six large USTs in October 1993, and was reported to the Nebraska State Fire Marshal Flammable Liquid Storage Division and the NDEQ in the tank closure assessment report (Terracon Environmental, Inc., 1993). Contaminated soils removed during the tank removal project were returned to the excavations. No evidence of contamination was observed during removal of the fuel oil UST located to the south of the others. Investigations and remedial actions performed subsequent to UST removal are described in Section 2.3.

2.2 TOPOGRAPHY, HYDROLOGY, GEOLOGY, AND HYDROGEOLOGY

2.2.1 Topography and Surface Hydrology

Offutt AFB is located on a dissected Pleistocene terrace embankment and Missouri River Valley bottomland (Woodward Clyde Consultants, 1995). The Building 406 site is located on the Pleistocene terrace approximately 995 feet above mean sea level. Surface water in the vicinity of Building 406 is primarily controlled by the storm sewer system which drains to Papillion Creek. Papillion Creek is located 2,400 feet southwest of the site at its nearest point. The Missouri River is approximately 1 mile



LEGEND

- MW406-1 — GROUNDWATER MONITORING WELL
- VW1 — AIR INJECTION VENT WELL
- MPA — MONITORING POINT
- GPSB1 — VAPOR SOIL SAMPLING LOCATION
- Ⓟ — POWER PANEL (230V,110V)
- - - ✕ - - — FENCE
- A——A' — LOCATION OF HYDROGEOLOGIC CROSS-SECTION

FIGURE 2.1

SITE LAYOUT

Building 406
Offutt Air Force Base, Nebraska

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from the eastern boundary of the base and approximately 2.5 miles from the Building 406 site.

2.2.2 Geology

The Pleistocene terrace geologic profile is typically surficial fill; loess; Pleistocene terrace alluvial clays, silts, and sands; and a clay-rich glacial till-outwash sand complex overlying Pennsylvanian bedrock. The Pennsylvanian bedrock is primarily composed of limestone and shales (Woodward Clyde Consultants, 1995).

During installation of the bioventing pilot test components (described in Section 2.3.3), soil samples were collected and analyzed for grain-size distribution by a geotechnical laboratory. The soil beneath the Building 406 site is characterized by silt with some clay and a trace of sand to a depth of at least 25 feet below ground surface (bgs) (ES, 1994). These observations suggest that the former tanks were located within the surficial fill and loess deposits. Bedrock was not encountered during any investigation activities, all of which terminated at depths of 25 feet bgs or less. Figure 2.2 presents the hydrogeologic cross-section of the site. The trace of the cross section is shown on Figure 2.1.

2.2.3 Hydrogeology

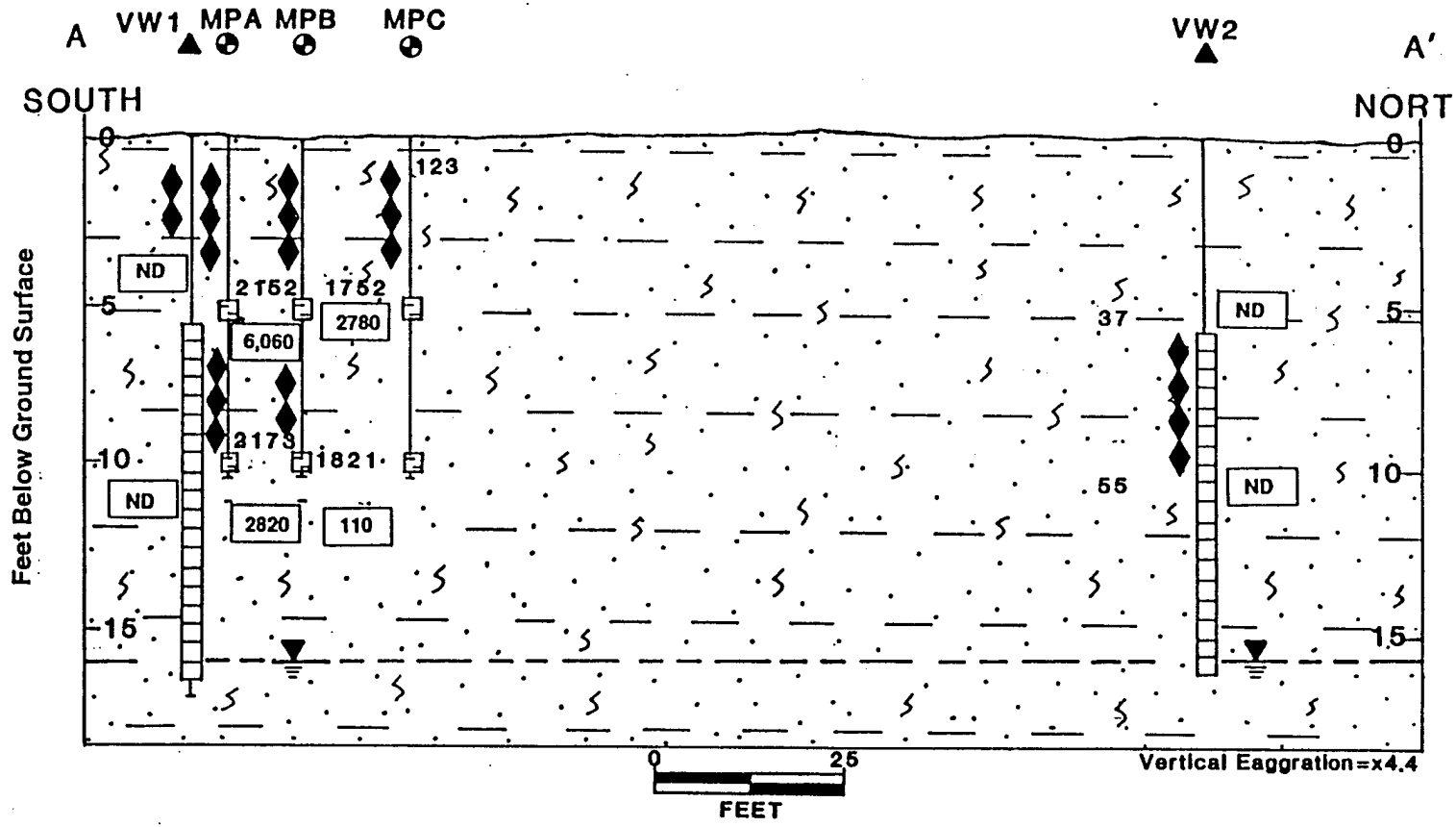
The unconsolidated material resting on the Pennsylvanian bedrock comprise the principal aquifer beneath the site. The clay-rich glacial till is considered an aquitard for the unconfined aquifer present in overlying Pleistocene alluvial deposits and loess (Woodward Clyde Consultants, 1995). The water table beneath the Building 406 site was present at a depth of approximately 17 to 20 feet bgs in February 1994, but was observed to be approximately 16 feet bgs during installation of the bioventing system in October 1993. Groundwater flow is to the west-southwest, as shown on Figure 2.3. Limited hydraulic conductivity data for the area indicate an alluvial aquifer conductivity of 0.0002 centimeters per second (Terracon Environmental, Inc., 1994). Assuming an average hydraulic gradient of 0.01 foot per foot (estimated from the 1994 groundwater elevation data) and a effective porosity of 0.40, the groundwater flow velocity is approximately 5 feet per year.

Groundwater is not currently used as a potable water source within Offutt AFB property. There are two abandoned groundwater production wells located on the Base, an emergency well (Well No. 9) in the underground command center at Facility 500, and an emergency standby fire protection well (Well No. 5) on the east side of the POL yard. Two domestic wells are located 2,000 feet south-southwest (downgradient) of the Base boundary (Woodward Clyde Consultants, 1995).

2.3 PREVIOUS INVESTIGATIONS

2.3.1 1993 Tank Removal

The seven USTs associated with Building 406 were removed, and a tank closure assessment was performed in October 1993 by Terracon Environmental, Inc., (1993). Upon removal, none of the tanks showed visible signs of leaks; however, contaminated



LITHOLOGIC DESCRIPTION

SILT WITH CLAY AND SAND

LEGEND

- MPA — MONITORING POINT
- VW1 — INJECTION VENT WELL
- 42 — FIELD SCREENING RESULTS FOR TOTAL VOLATILE HYDROCARBONS (ppmv)
- 42 — LABORATORY RESULTS FOR SOIL TOTAL PETROLEUM HYDROCARBONS (mg/kg)
- FUEL ODOR DETECTED DURING DRILLING
- GROUNDWATER ELEVATION (10/93)
- GEOLOGIC CONTACT, DASHED WHERE INFERRED
- MONITORING POINT SCREENED INTERVAL
- SCREENED WELL INTERVAL
- ND — NOT DETECTED

FIGURE 2.2

HYDROGEOLOGIC CROSS SECTION A-A'

Building 406
Offutt Air Force Base, Nebraska

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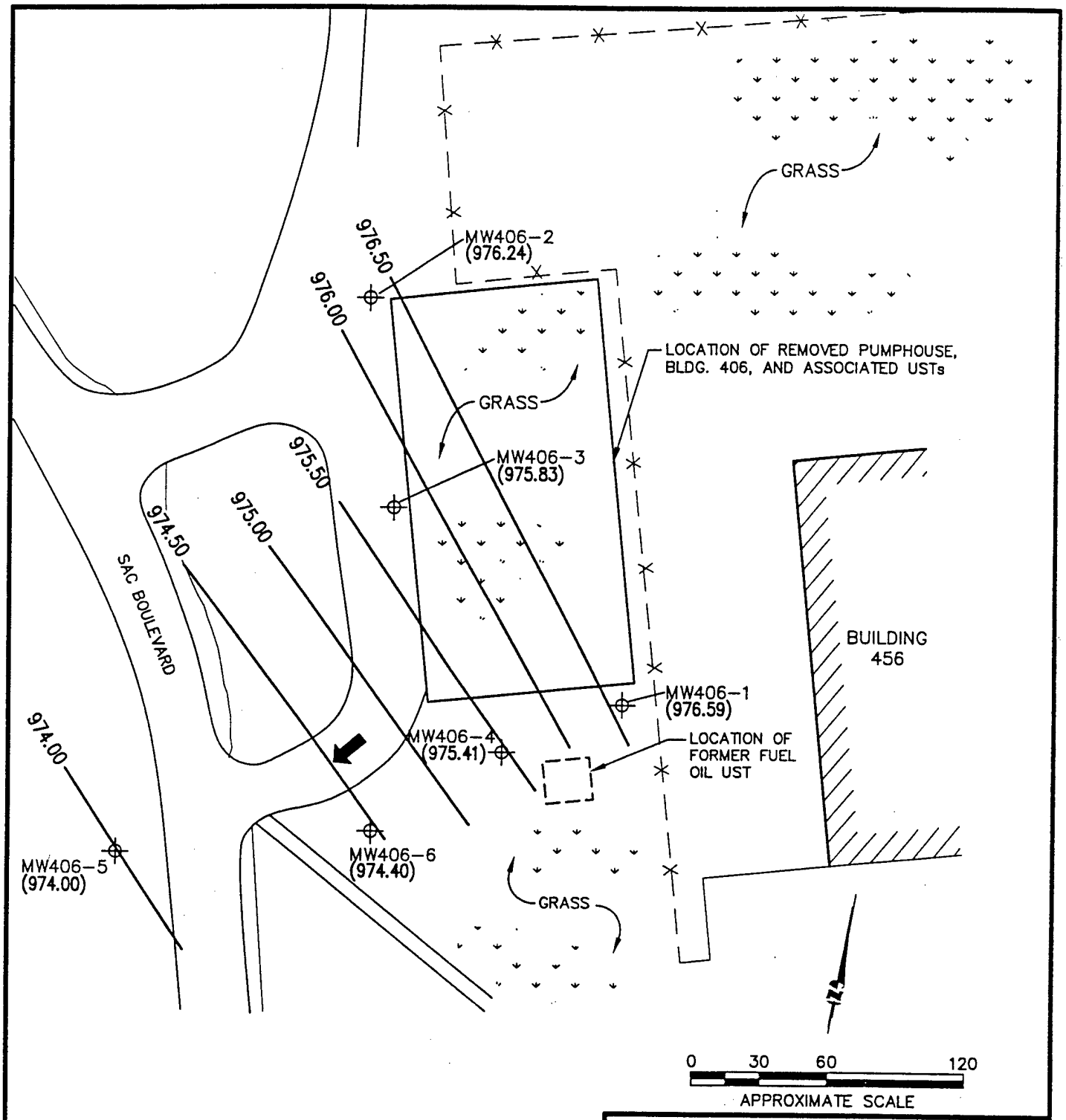

LEGEND

MW406-1 — MONITORING WELL

(976.59) — GROUNDWATER ELEVATION, FEBRUARY 1994 (feet above mean sea level)

FENCE

GROUNDWATER FLOW DIRECTION

975.00 — LINE OF EQUAL GROUNDWATER ELEVATION (feet above mean sea level)

FIGURE 2.3

GROUNDWATER ELEVATIONS AND FLOW DIRECTION FEBRUARY 1994

Building 406
Offutt Air Force Base, Nebraska

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soils were observed in the removal excavation for the six 51,000-gallon USTs. Soils had a greenish color and a distinctive hydrocarbon odor. Composite soil sample headspace readings indicated total volatile hydrocarbons (TVH) in the range of 200 to 400 parts per million, volume per volume (ppmv). No indication of soil contamination was observed in the excavation for the 560-gallon fuel oil UST. Soil samples were collected from both excavations, and the analytical results are presented in Table 2.1 (Terracon Environmental Inc., 1993).

The excavation for the six larger tanks was at least 16 feet deep, allowing groundwater to accumulate. Groundwater samples were collected from the excavation and analyzed for total recoverable petroleum hydrocarbons (TRPH) by US Environmental Protection Agency (USEPA) Method 418.1 and for benzene, toluene, ethylbenzene, and total xylenes (BTEX) by USEPA Method SW8020. The groundwater analytical results are presented in Table 2.2.

2.3.2 1994 Groundwater Investigation

During a November 2, 1993 meeting, the NDEQ indicated that investigation of the nature and extent of groundwater contamination, if present, was required at Building 406. Terracon Environmental, Inc. (1994) installed six soil boreholes, and completed them as monitoring wells between August 27, 1993 and February 21, 1994. Figure 2.3 shows the locations of the monitoring wells.

During installation of the boreholes, soil samples were collected at 5-foot intervals and screened for volatile organic compounds (VOCs) using a photoionization detector (PID). The results, presented in Table 2.3, indicate that soils at wells MW406-1 and MW406-3 are contaminated near the groundwater surface, and that only at MW406-4 was there significant vadose zone contamination.

Groundwater samples were collected from each well between December 20, 1993 and February 21, 1994 and were analyzed for BTEX by USEPA Method SW8020 and TRPH by USEPA Method 418.1. The results, presented in Table 2.4, indicate minor impact to the groundwater in the immediate vicinity of the former tanks. No drinking water maximum contaminant levels (MCLs) were exceeded. No further groundwater investigation has been performed at this site.

2.3.3 1993-1997 Bioventing Pilot Test

In October 1993, a full-scale bioventing system was installed at the Building 406 site by ES (1994) as part of the AFCEE Bioventing Pilot Test Initiative Project. The Building 406 site at Offutt AFB was the first full-scale bioventing system installed in USEPA Region 7. Objectives of the pilot test were to inject air into the subsurface to supply native hydrocarbon degrading bacteria with oxygen, determine the rate at which the indigenous microorganisms would degrade fuel when stimulated by oxygen-rich soil gas, and to evaluate the potential for sustaining these rates of biodegradation until fuel contamination was remediated to concentrations below NDEQ standards.

TABLE 2.1
SOIL ANALYTICAL RESULTS FROM TANK REMOVAL EXCAVATIONS
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

Sample ID	Depth Sampled (feet bgs[c/])	Sample Location	Volatile Organic Compounds SW8020					TRPH[a/] EPA 418.1 (mg/kg)
			Benzene (mg/kg)[d/]	Toluene (mg/kg)	Ethyl-benzene (mg/kg)	Total Xylenes (mg/kg)	Total BTEX[b/] (mg/kg)	
1T	15	north excavation	1.6 U[e/]	1.6 U	4.3	2.6	6.9	400
2T	15	north excavation	0.005 U	0.005 U	0.048	0.124	0.172	22
3T	15	north excavation	0.160 U	0.190	1.2	19.0	20.4	690
4T	15	north excavation	0.2 U	0.3	1.1	0.6	2.0	130
#7 T1	6	south excavation	NA[f/]	NA	NA	NA	NA	47
#7 2T	6	south excavation	NA	NA	NA	NA	NA	89

Source: Terracon Envrionmental, Inc., 1993.

a/ TRPH = Total recoverable petroleum hydrocarbons.

b/ BTEX = Benzene, toluene, ethylbenzene, and total xylenes.

c/ bgs = Below ground surface.

d/ mg/kg = Milligrams per kilogram.

e/ U - Indicates compound was analyzed for but not detected. Sample quantitation limit shown.

TABLE 2.2
TANK EXCAVATION GROUNDWATER ANALYTICAL RESULTS
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

Sample ID	Date Sampled		Volatile Organic Compounds SW8020				Total BTEX (µg/L)	TRPH[a/] EPA 418.1 (mg/L)[d/]
	BTEX[b/]	TRPH	Benzene (µg/L)[c/]	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)		
T-1	9/21/93	9/21/93	3,700	500	2,500	3,100	9,800	15
T-2	9/20/93	9/20/93	3,900	200 U[e/]	2,400	1,700	8,000	150
T-3	9/17/93	9/17/93	1,900	200 U	1,000	1,300	4,200	3.4
T-5	9/24/93	9/24/93	9.0	42	10	130	191	1.0 U
T-6	9/23/93	9/23/93	12	150	6.0	29		1.0 U

Source: Terracon Envrionmental, Inc., 1993.

a/ TRPH = Total recoverable petroleum hydrocarbons.

b/ BTEX = Benzene, toluene, ethylbenzene, and total xylenes.

c/ µg/L = Micrograms per liter.

d/ mg/L = Milligrams per liter.

e/ U - Indicates compound was analyzed for but not detected. Sample quantitation limit shown.

TABLE 2.3
FIELD SCREENING RESULTS FOR MONITORING WELL BOREHOLE SOIL SAMPLES
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

Sample Depth (feet)	Field Screening Results (ppmv)[a/]					
	MW 406-1	MW 406-2	MW 406-3	MW 406-4	MW 406-5	MW 406-6
3.0 - 5.0	<1	<1	<1	310	3	<1
8.0 - 10.0	<1	<1	<1	410	2	<1
13.0 - 15.0	<1	<1	<1	79	4	<1
18.0 - 20.0	<1	<1	390	120	4	<1
22.0 - 23.0	510	<1	-[b/]	240	-	9

Source: Terracon Envrionmental, Inc., 1994.

[a/] Field screeing results obtained with a photoionization detector; ppmv = parts per million, volume per volume.

[b/] Borehole not advanced to reported depth.

TABLE 2.4
MONITORING WELL GROUNDWATER ANALYTICAL RESULTS
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

Sample ID	Date Sampled		Volatile Organic Compounds SW8020				Total BTEX	TRPH[a/] EPA 418.1
	BTEX[b/]	TRPH	Benzene (µg/L)[c/]	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	(µg/L)	(mg/L)[d/]
MW 406-1	9/17/93	2/11/94	2 U[e/]	2 U	2 U	2 U	ND[f/]	1.0 U
MW 406-2	1/5/94	2/1/94	2 U	2 U	2 U	2.4	2.4	1.0 U
MW 406-3	12/20/93	2/1/94	2 U	4.0	5.2	21	30.2	1.0 U
MW 406-4	1/5/94	2/1/94	2 U	2.1	3.1	12	17.2	2.2
MW 406-5	1/7/94	2/1/94	2 U	2 U	2 U	3.1	3.1	1.0 U
MW 406-6	2/21/94	2/21/94	4 U	4 U	5.6	23	28.6	1.0 U
MCL[g/]	-	-	5	1,000	700	10,000	-	-

Source: Terracon Envrionmental, Inc., 1994.

a/ TRPH = Total recoverable petroleum hydrocarbons.

b/ BTEX = Benzene, toluene, ethylbenzene, and total xylenes.

c/ µg/L = Micrograms per liter.

d/ mg/L = Milligrams per liter.

e/ U - Indicates compound was analyzed for but not detected. Sample quantitation limit shown.

f/ ND = not detected

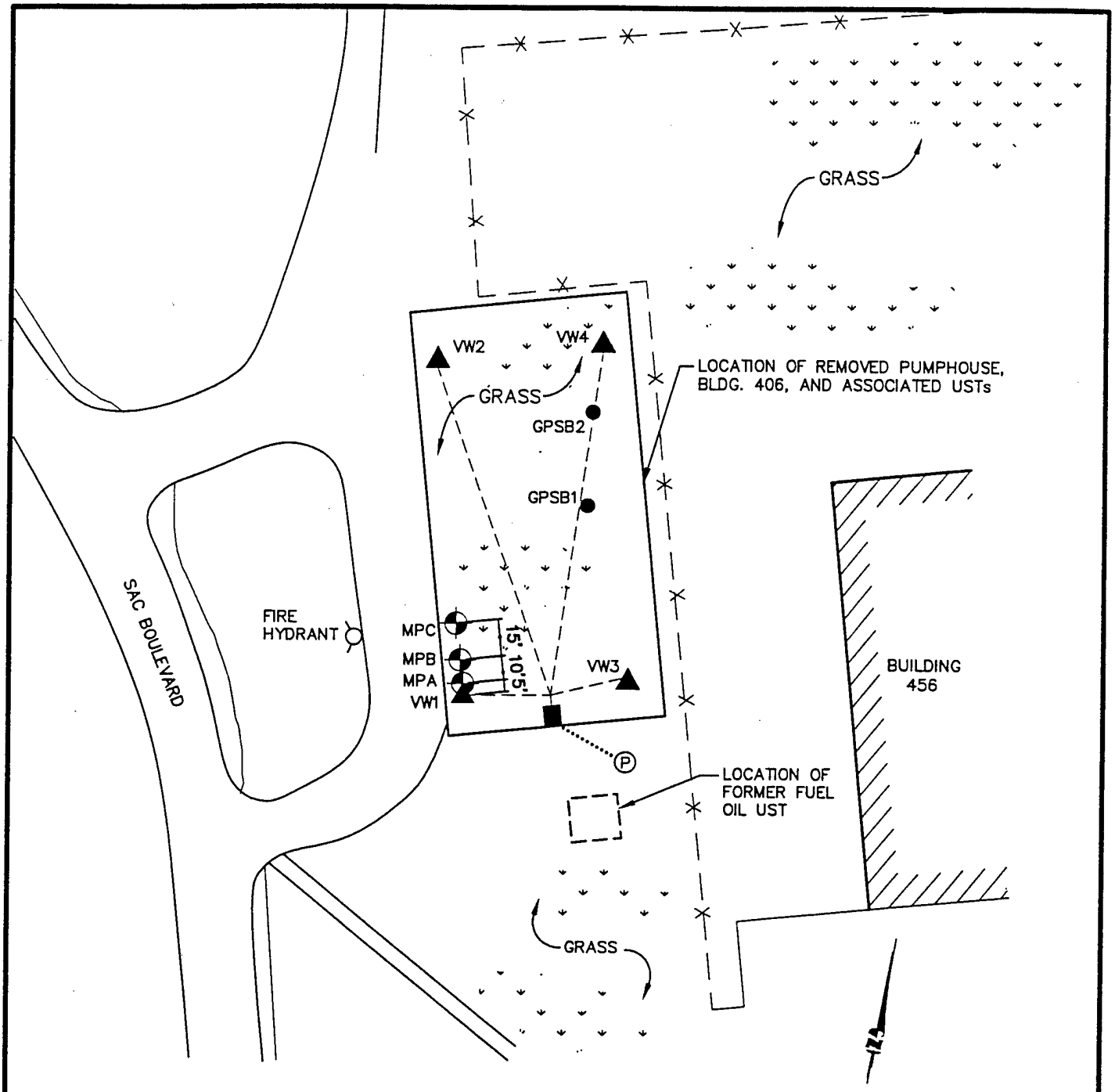
g/ MCL = maximum contaminant level (USEPA, 1996a)

The full-scale bioventing system consisted of four vent wells (VWs), three multi-depth vapor monitoring points (MPs), and a blower unit. Pilot testing activities performed during installation included respiration and air permeability testing and soil and soil gas sampling. The Bioventing Pilot Test Initiative Project provided for 1 year of system operation followed by soil gas sampling and respiration testing. However, the NDEQ, in cooperation with AFCEE, funded an additional year (year 2) of system operation followed by soil gas sampling and respiration testing. Following the second year of operation, additional soil samples were collected in October 1995 from two newly installed sampling locations (GPSB1 and GPSB2), as well as from the locations previously sampled.

Figure 2.4 shows the locations of the bioventing system components. As part of the investigation at the time of system installation, soil samples were collected at 5-foot intervals from all VW and MP boreholes. All soil samples were field screened with a PID, and 12 samples were analyzed for BTEX, TRPH, nutrients, moisture, and grain-size distribution analyses. Soil gas samples also were collected from VW1 and the 10-foot intervals of MPA and MPB and analyzed for BTEX and TVH. Based on field screening results, hydrocarbon contamination generally was present from about 5 to 16 feet bgs. Contaminated soils were encountered in all MP boreholes, with the greatest contamination occurring at 10 feet bgs at MPA.

Table 2.5 summarizes the BTEX and TRPH analytical results for the soil samples collected at the time of bioventing system installation, as well as for samples collected from these locations after years 1 and 2 of bioventing treatment. Results for samples collected from GPSB1 and GPSB2, first sampled during the 1-year sampling event, also are presented. The soil analytical results indicate that bioventing has significantly reduced BTEX concentrations in soils. TRPH concentrations decreased at nine sampling locations, increased at two locations, and remained constant (below laboratory detection limits) at five sampling locations during the first 2 years of bioventing. Apparent increases in TRPH concentrations are not uncommon because of the heterogeneity of soils which can result in selective TRPH adsorption characteristics and variability in TRPH analytical results. Overall, the soil analytical results indicate that bioventing has reduced TRPH and BTEX concentrations in soils at the Building 406 site (Table 2.5).

The Building 406 site was funded for a third year of operation and monitoring of the bioventing system under the Extended Bioventing Program. The funding included an additional year of system operation and testing (Option 1) and confirmation soil sampling (Option 2) to document the effectiveness of soil remediation at the site. The 1-year operation and maintenance support period under Option 1 began following the October 1995 (2-year) sampling event. Respiration testing and soil gas sampling were performed in November 1996 (3-year sampling event) following 1 month of system shut down to allow equilibrium conditions to develop in site soil vapors and to allow comparison to initial, 1-year, and 2-year analytical results. Soil sampling was not performed during the 3-year sampling event. The bioventing system has been operating since the November 1996 sampling event, except during short periods following blower unit failure. The blower was subsequently replaced.



LEGEND

- VW1 ▲ AIR INJECTION VENT WELL
- MPA ⊕ MONITORING POINT
- GPSB1 ● SOIL SAMPLING LOCATION
- ■ BLOWER AND BLOWER ENCLOSURE
- Ⓟ POWER PANEL (230V, 110V)
- --×-- FENCE
- ----- BURIED AIR INJECTION LINE (2" PVC)
- ..... BURIED ELECTRICAL CONDUIT (230V, 30A)

FIGURE 2.4

AS-BUILT VENT WELL, MONITORING POINT, AND BLOWER LOCATIONS

Building 406
Offutt Air Force Base, Nebraska

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

K:\AFCEE\722408\97DN0535, 07/25/97 at 10:35

TABLE 2.5
INITIAL, 1-YEAR, AND 2-YEAR SOIL ANALYTICAL RESULTS
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

Analyte (Units) [a]	Sample Locations-Depth (feet below ground surface)											
	VW1-5			VW1-10			MPA-5			MPA-10		
Soil Hydrocarbons	Initial [b]	1-Year [c]	2-Year [d/e]	Initial	1-Year	2-Year [e]	Initial	1-Year	2-Year	Initial	1-Year	2-Year
TRPH (mg/kg)	<8.0	<12.5	<50/<50	<6.5	<12.5	<50/<50	6,060	6,070	1,300	2,820	5,000	<50
Benzene (mg/kg)	<0.0020	<0.061	<0.10/<0.10	0.0073	<0.063	<0.10/<0.10	20	<0.061	<0.10	7.4	<0.056	<0.10
Toluene (mg/kg)	<0.0020	<0.061	<0.10/<0.10	0.0007	<0.063	<0.10/<0.10	<5	1.9	<0.10	5	5.5	<0.10
Ethylbenzene (mg/kg)	<0.0020	<0.061	<0.10/<0.10	0.0044	<0.063	<0.10/<0.10	270	<0.061	<0.10	78	<0.056	<0.10
Xylenes (mg/kg)	<0.0020	<0.12 [f]	<0.20/<0.20	0.007	<0.13	<0.20/<0.20	380	7.5	<0.20	130	14	<0.20
Moisture (%)	NS [g]	20.5	21.7/22.2	23	21.6	24.2/22.8	NS	19.5	22.0	23	11.5	23.9
	MPB-5			MPB-10			VW2-5			VW2-10		
Soil Hydrocarbons	Initial [b]	1-Year [c]	2-Year [d]	Initial	1-Year	2-Year	Initial	1-Year	2-Year	Initial	1-Year	2-Year
TRPH (mg/kg)	2,780	2,270	<50	110	223	<50	<8.0	<12.3	<50	<6.6	<12.9	<50
Benzene (mg/kg)	<1.0	<0.062	<0.10	1.2	<0.062	<0.10	<0.0020	<0.062	<0.10	<0.0006	<0.064	<0.10
Toluene (mg/kg)	<1.0	0.71	<0.10	0.58	<0.062	<0.10	<0.0020	<0.062	<0.10	0.0049	<0.064	<0.10
Ethylbenzene (mg/kg)	43	<0.062	<0.10	4.7	<0.062	<0.10	<0.0020	<0.062	<0.10	<0.0006	<0.064	<0.10
Xylenes (mg/kg)	49	0.51	<0.20	10	<0.12	<0.20	<0.0020	<0.12	<0.20	0.0052	<0.13	<0.20
Moisture (%)	NS	20.4	21.3	22	20.7	22.9	NS	19.5	20.9	24	22.2	23.9
	VW3-5			VW3-10			VW4-5			VW4-10		
Soil Hydrocarbons	Initial [b]	1-Year [c]	2-Year [d]	Initial	1-Year	2-Year	Initial	1-Year	2-Year	Initial	1-Year	2-Year
TRPH (mg/kg)	1,300	11,700	<50	94	19.3	390	600	30.3	<50	<6.5	<12.9	<50
Benzene (mg/kg)	<0.25	<0.062	<0.10	3.6	0.17	1.3	<0.50	<0.062	<0.10	<0.16	<0.064	<0.10
Toluene (mg/kg)	<0.25	0.97	<0.10	<3.1	0.13	<0.50	1.1	<0.062	<0.10	8.8	<0.064	<0.10
Ethylbenzene (mg/kg)	12	<0.062	0.16	8.6	<0.062	28	<0.50	<0.062	<0.10	0.52	<0.064	<0.10
Xylenes (mg/kg)	14	1.2	<0.20	22	0.17	48	1.2	<0.12	<0.20	2.5	<0.13	<0.20
Moisture (%)	NS	18.7	4.0	20	20.1	18.2	NS	20.3	21.1	23	22.5	21.4

TABLE 2.5, (CONTINUED)
INITIAL, 1-YEAR, AND 2-YEAR SOIL ANALYTICAL RESULTS
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

Analyte (Units) [a]	Sample Locations-Depth (feet below ground surface)											
	GPSB1-5			GPSB1-10			GPSB2-5			GPSB2-10		
Soil Hydrocarbons	Initial [b]	1-Year [c]	2-Year [d]	Initial	1-Year	2-Year	Initial	1-Year	2-Year	Initial	1-Year	2-Year
TRPH (mg/kg)	NS	724	<50	NS	66	430	NS	1,150	100	NS	35.8	<50
Benzene (mg/kg)	NS	<0.063	<0.20	NS	0.097	<0.50	NS	<0.058	<0.10	NS	0.11	0.13
Toluene (mg/kg)	NS	0.80	<0.20	NS	1.6	<0.50	NS	1.3	0.13	NS	1.3	<0.10
Ethylbenzene (mg/kg)	NS	<0.063	5.2	NS	<0.063	8.1	NS	0.089	2.8	NS	<0.064	0.71
Xylenes (mg/kg)	NS	0.63	3.5	NS	0.280	4.0	NS	1.2	1.9	NS	3.9	1.1
Moisture (%)	NS	21.2	20.4	NS	20.9	20.4	NS	18.4	16.0	NS	22.3	19.1

[a] TRPH = total recoverable petroleum hydrocarbons analyzed by USEPA Method 418.1; benzene, toluene, ethylbenzene, and total xylenes analyzed by USEPA Method SW8020; mg/kg = milligrams per kilogram.
[b] Initial soil samples collected on October 20-22, 1993.
[c] 1-Year soil samples collected on October 11-12, 1994.
[d] 2-Year soil samples collected on September 28-29, 1995.
[e] Primary sample result/replicate sample result.
[f] Sample result as reported following 1-year sampling event was incorrect. Correct result is shown.
[g] NS = not sampled

Table 2.6 summarizes the oxygen, carbon dioxide, BTEX, and TVH results for the soil gas samples collected at the time of bioventing system installation and after 1, 2, and 3 years of bioventing treatment. All soil gas measurements shown are for soil gas at equilibrium, with the blower system not in operation. The laboratory data indicate reductions in TVH concentrations of between two and four orders of magnitude during the 3 years of bioventing. BTEX concentrations in soil gas have been reduced to nearly non-detectable levels.

Initial soil gas testing indicated depleted oxygen concentrations and high TVH concentrations at all 10-foot MP intervals and at VW-1. This suggested that air injection would oxygenate contaminated soils and enhance biodegradation of residual petroleum hydrocarbons by native aerobic soil microbes. The air permeability test indicated a radius of pressure influence of at least 30 feet, and an air permeability of 3.6 darcys.

In situ respiration tests were performed during pilot testing activities at the time of system installation. The results provided an oxygen utilization rate from which fuel hydrocarbon biodegradation rates were estimated. Based on the initial respiration testing event, fuel biodegradation rates ranging from 1,000 to 24,000 mg of fuel per kg of soil per year (mg/kg/yr) were estimated. Respiration tests were also performed during 6-month, 1-year, 18-month, 2-year, and 3-year testing events. The results of the follow up respiration tests, shown in Table 2.7, indicate that significant reductions in oxygen utilization and fuel biodegradation rates have occurred as a result of bioventing system operation. Oxygen utilization and fuel biodegradation rates typically decrease with continued bioventing as the lighter, more readily biodegraded hydrocarbons are preferentially degraded over more biologically recalcitrant, higher-molecular-weight hydrocarbons. The BTEX compounds, as demonstrated by the soil gas results (Table 2.6), have been almost completely biodegraded.

The details of the bioventing system installation and preliminary pilot test and analytical results are presented in the bioventing pilot test work plan and draft interim pilot test results report (ES, 1994). The 1-year, 2-year, and 3-year test results are summarized in a 30 January 1995 letter (Parsons ES, 1995), a 25 February 1996 letter (AFCEE, 1996), and a 29 January, 1997 (Parsons ES, 1997), respectively.

2.3.6 Results Summary

Based on the results of the previous investigations, the former JP-4 USTs have been identified as the probable source of the petroleum hydrocarbon contamination at the Building 406 site. Investigation results indicate that the majority of the vadose zone contamination has been limited to the soils near the former USTs. Field screening of soil samples collected during installation of the monitoring wells indicated that vadose zone soils beyond the limits of the UST excavation have not been significantly impacted (Table 2.1). Therefore, the majority of the vadose zone contamination is within the bioventing system treatment area (Figure 2.4). Results of the bioventing testing indicate that significant reductions in soil TRPH and BTEX concentrations have occurred as the result of bioventing (Tables 2.5 and 2.6). In addition, fuel biodegradation rates have decreased as fuel hydrocarbon concentrations decrease;

TABLE 2.6
SOIL GAS FIELD AND LABORATORY ANALYTICAL RESULTS
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

		Field Screening Data			Laboratory Analytical Results[d]				
Sampling Location[a]	Sampling Event[b]	Oxygen (percent)	Carbon Dioxide (percent)	TVH (ppmv)[c]	TVH (ppmv)	Benzene (ppmv)	Toluene (ppmv)	Ethylbenzene (ppmv)	Xylenes (ppmv)
VW1	Initial	1.5	9.8	9,400	14,000	200	<1.1[e]	41	41
	1-Year	---[f]	---	---	460	<0.027	<0.027	1.7	6.8
	2-Year	10.5[g]	0.1[g]	12[g]	2.8	0.008	0.003	<0.003	0.009
	3-Year	16.2	0.1	30	6.5	0.004	0.022[h]	0.03	0.28[h]
MPA-5	Initial	20.0	0.4	1200	---	---	---	---	---
	3-Year	4.9	4.0	600	---	---	---	---	---
MPA-10	Initial	0.0	11.5	>20,000[i]	15,000	290	<2.2	50	60
	1-Year	---	---	---	4,900	<0.055	<0.055	13	62
	2-Year	2.1[g]	0.8[g]	290[g]	1,500	0.09[h]	2.8[h]	<0.064	6.3
	3-Year	0.0	2.3	2,400	860	<0.026	0.27	<0.026	4.5[h]
MPB-5	Initial	18.5	1.8	1,800	---	---	---	---	---
	3-Year	0.0	6.2	1,600	---	---	---	---	---
MPB-10	Initial	0.5	10.5	>20,000	26,000	370	<2.2	40	52
	1-Year	---	---	---	1,400	<0.053	<0.053	4.9	14
	2-Year	0.0[g]	1.0[g]	64[g]	310	0.57	0.6	<0.011	<0.011
	3-Year	0.0	2.5	5,000	94	<0.005	0.21	<0.005	0.30[h]
MPC-5	Initial	16.5	3.1	2,300	---	---	---	---	---
	3-Year	1.0	14.0	2,000	---	---	---	---	---
MPC-10	Initial	0.0	10.8	7,300	---	---	---	---	---
	1-Year	---	---	---	---	---	---	---	---
	2-Year	2.5[g]	2.8[g]	3,800[g]	---	---	---	---	---
	3-Year	3.2	14.2	2,800	---	---	---	---	---

[a] Sample location identifies the monitoring point and depth in feet below ground surface.
[b] Soil gas sampling performed in October 1993, October 1994, October 1995, and November 1996
[c] TVH=total volatile hydrocarbons: ppmv = parts per million, volume per volume.
[d] Soil gas analysis performed using USEPA Method TO-3.
[e] < = analyte concentration in sample was less than the method detection limit showwn.
[f] --- = not analyzed.
[g] 2-year field screening results are the last respiration test data available for this location.
[h] Laboratory reported value may be biased due to apparent matrix interferences.
[i] > = measurement exceeded maximum reading for GasTech Trace-Techtor Hydrocarbon Analyzer.

022/726876/OFFUTT/2.XLS/TAB 2.6

TABLE 2.7
RESPIRATION AND DEGRADATION RATES
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

Location-Depth (feet below ground surface)	Initial (October 1993)			6-Month (April 1994) [b/]			1-Year (October 1994)		
	K_o (% O_2/hour)	Degradation Rate (mg/kg/year)[a]	Soil Temperature (°C)	K_o (% O_2/hour)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/hour)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
VW	2.9	6,900	NS [c/]	NC	NC	NS	NC	NC	NS
MPA-5	NC [d/]	NC	14.7	NC	NC	9.3	NC	NC	21.4
MPA-10	10.2	24,000	15.9	0.22	910	11.2	0.35	2,200	20.7
MPB-10	0.40	1,000	NS	0.23	630	NS	0.32	940	NS
MPC-10	9.0	23,000	NS	0.55	1,500	NS	0.12	350	NS

Location-Depth (feet below ground surface)	18-Month (April 1995)[e/]			2-Year (September 1995)			3-Year (November 1996)[f/]		
	K_o (% O_2/hour)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/hour)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/hour)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
VW	NS	NS	NS	0.07	160	NS	0.04	99	NS
MPA-5	NS	NS	10.0	NC	NC	23.1	NS	NS	NS
MPA-10	0.28	1,000	12.1	0.84	1,600	20.5	0.52	970	NS
MPB-10	0.12	290	NS	0.27	600	NS	0.21	460	NS
MPC-10	0.10	230	NS	1.5	3,300	NS	1.4	3,100	NS

[a/] Milligrams of hydrocarbons per kilogram of soil per year.
[b/] Assumes moisture content of the soil is average of initial and 1-year moistures.
[c/] NS = Not sampled.
[d/] NC = Not calculated.
[e/] Assumes moisture content of the soil is the average of the 1-year and 2-year moistures.
[f/] Assumes moisture content of the soil the same as 2-year moistures.

however, significant rates of fuel biodegradation degradation were observed during the 3-year testing event (Table 2.7).

Analytical results of groundwater samples indicate minor impacts on the groundwater in the immediate vicinity of the former tanks (Tables 2.2 and 2.4). No drinking water MCLs were exceeded by the BTEX compounds detected in groundwater. Based on conversations with the NDEQ, no further groundwater investigation is required at this site (Nancy Mann, 1997).

SECTION 3

SITE CLEANUP REQUIREMENTS

3.1 SITE CHARACTERIZATION REQUIREMENTS

The objective of the confirmatory soil sampling is to support an NFRAP recommendation for the soils contaminated by jet fuel in the immediate vicinity of the former JP-4 USTs, pursuant to closure of the Building 406 site. This sampling plan targets only unsaturated soils within the former excavation as these are the soils for which the NDEQ requested remediation (i.e., the contaminated soils were returned to the excavation). Sampling of soils beyond the excavation limits and sampling of groundwater are not required.

3.2 STATE SOIL CLEANUP STANDARDS

NDEQ (1991) determines soil and groundwater cleanup levels on a case-by-case basis, depending on site conditions. Cleanup standards are dependent on the beneficial use classification of the aquifer impacted or potentially impacted by soil petroleum hydrocarbon contamination. A remedial action class (RAC) is defined for pollution occurrences in three types of groundwater (or overlying soils), depending on the degree of (or potential for) use of the groundwater as a drinking water. The extent of remedial action required differs depending on the RAC of the contaminated (or likely to be contaminated) groundwater.

Definitions of the three RACs are summarized below (NDEQ 1991).

RAC-1 includes petroleum contamination of:

- Groundwaters currently being used as a public and/or private drinking water supply;
- Groundwaters intended to be used in a public drinking water system; or
- Groundwaters within 500 feet of a private drinking water-supply well.

RAC-2 includes petroleum contamination of:

- Groundwaters not now directly used as drinking water, but having the potential to be used in the future.

RAC-3 includes, but is not limited to, petroleum contamination of:

- Groundwaters not used, and unlikely to be used, as drinking water.

Factors that may result in a RAC-3 classification include:

- Poor natural quality of the groundwater, making it unfit for human consumption;
- Poor aquifer yields; and
- Past and present intensive land use including areas of industrial development or densely populated areas where groundwater is likely to be contaminated or will not be used as drinking water.

The Building 406 site has been classified as a RAC-3 occurrence. Typically the only remedial action required for a RAC-3 occurrence is removal of readily removable contaminants (i.e., free product). However, because contaminated soils were returned to the excavation following removal of the USTs, the NDEQ requested remedial action for these soils. Specific soil cleanup levels have not been defined for this site, and the NDEQ is not requiring further groundwater investigation (Nancy Mann, 1997).

3.3 PROPOSED SOIL CLEANUP GOALS

The American Society for Testing and Materials (ASTM, 1995) has developed a tiered, risk-based corrective action (RBCA) approach for petroleum-hydrocarbon-contaminated sites. This iterative approach allows first for screening of contaminant concentrations against generic risk-based concentrations, followed (if necessary) by the development of site-specific cleanup criteria based on an analysis of site data and receptors that could potentially be exposed to chemical contamination at, or downgradient from, the release site. In the absence of state soil clean up goals, Parsons ES and Offutt AFB will reference the ASTM RBCA standard for soil cleanup standards. Because RBCA criteria are based on current or foreseeable land uses and human receptor exposure scenarios, a review of available information is provided below.

3.3.1 Land Use and Potential Receptors

Current land use adjacent to the site is predominantly industrial, although the Base golf course is located to the east of (and upgradient from) the site. Future land for the Building 406 site and adjacent land will continue to be predominantly industrial. Based on the future industrial land use assumption and the site description presented in Section 2, current and future onsite workers are likely to represent the primary human receptor population. No ecological receptors are likely to be exposed to contaminants in site media under current or anticipated future land uses.

Groundwater within Offutt AFB property is not currently used as a potable water source; Moreover, site groundwater impacts from the JP-4 releases are minimal (Tables 2.2 and 2.4). Therefore, exposure of onsite and off-site human receptors to site contaminants through ingestion of, inhalation of, or dermal contact with contaminants in groundwater extracted for potable use is unlikely. More likely exposure pathways include VOC volatilization and migration into outdoor air or buildings, and incidental

ingestion of or dermal contact with surficial soil. Volatilization of fuel hydrocarbons from soil and vapor migration into onsite or off-site structures is expected to be the most significant potential exposure pathway resulting from contamination at the Building 406 site. This exposure pathway generally results in the lowest screening levels, and is therefore the most conservative of the potential exposure pathways.

3.3.2 Cleanup Goals

The ASTM (1995) RBCA standard risk-based screening levels (RBSLs) for soil, presented in a look-up table, are utilized in the Tier 1 evaluation of site contaminant concentrations. The RBSLs are not intended as cleanup goals but serve as conservative values against which to compare site contaminant concentrations. If site contaminant concentrations are lower than the RBSLs, then the RBCA standard suggests that no further corrective action is required. If site contaminant concentrations exceed the RBSLs, then site-specific target levels (SSTLs) can be developed through a Tier 2 evaluation.

BTEX and other common petroleum contaminant (e.g., polynuclear aromatic hydrocarbon [PAH]) concentrations in soil at Building 406 will be determined from the soil samples (to be collected and analyzed in accordance with Section 4), in order to compare these values with ASTM RBSLs. If the detected site contaminant concentrations do not exceed the most stringent RBSLs, the compounds will not be considered chemicals of potential concern (COPCs), and will not be retained for further Tier 2 evaluation. Under these circumstances, no additional remediation would be warranted for such compounds in order to protect potential receptors. If a detected site contaminant exceeds the appropriate RBSL, the compound is identified as a COPC and retained for further quantitative fate and transport and risk analyses.

For the purpose of comparison, generic RBSLs for commercial/industrial land use and maximum TRPH and BTEX soil concentrations detected during previous site investigations (Section 2.3) are presented in Table 3.1. The generic screening-level concentrations from the ASTM (1995) *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* and the USEPA (1996b) *Soil Screening Guidance: Technical Background Document* are presented. As previously mentioned, volatilization of hydrocarbon contaminants from soil resulting in vapor migration to buildings is likely to represent the most significant contaminant migration and potential receptor exposure pathway represented by hydrocarbon-contaminated soils at the Building 406 site. As can be seen in Table 3.1, the only detected soil contaminant exceeding its ASTM (1995) RBSL or USEPA (1996b) soil screening level (SSL) is benzene found in a sample collected in October 1993.

TABLE 3.1
SOIL CONTAMINANT LEVELS COMPARED TO SCREENING LEVELS
BUILDING 406
OFFUTT AIR FORCE BASE, NEBRASKA

	Units[c]	Detected Site Maximum Concentration	Date	ASTM[a] Comm/Indus Soil Vapor Intrusion RBSL[d]	USEPA[b] Ingestion SSL	USEPA[b] Inhalation SSL
TRPH	mg/kg	11,700	October 1994	NA[e]	NA	NA
Benzene	mg/kg	20	October 1993	0.0109	22	0.8
Toluene	mg/kg	8.8	October 1993	54.5	16,000	650
Ethylbenzene	mg/kg	270	October 1993	1,100	7,800	400
Xylenes	mg/kg	380	October 1993	RES[f]	160,000[g]	410[g]
Naphthalene	mg/kg	---[h]	NA	107	3,100	NA

Note: The corrective action limits or target concentrations exceeded by the maximum site concentration detected are shown in gray.

[a] Risk-based screening levels (RBSLs) from Table X2.1 (ASTM, 1995).

[b] Generic soil screening levels (SSLs) from Table A-1 (USEPA, 1996).

[c] mg/kg = milligrams per kilogram.

[d] Values shown represent example Tier 1 Risk-Based Screening Levels (RBSLs) for commercial/industrial receptor scenario considering soil-vapor intrusion from soil onto buildings (ASTM, 1995).

[e] Target concentrations not available in the sources referenced.

[f] RES = Selected risk level is not exceeded for pure compound present at any concentration (ASTM, 1995).

[g] SSL data provided is for *o*-xylene, which has the most conservative SSLs of the three xylene isomers.

[h] --- = no site data yet available for this analyte.

SECTION 4

SITE CONFIRMATION SOIL SAMPLING AND ANALYSIS PLAN

This section describes the borehole locations, sampling depths, soil sampling procedures, and analytical methods proposed to collect sufficient data to verify remediation of Building 406 site soils and to support site closure. As described in Section 2, the Building 406 site was characterized during investigations in 1993 and 1994. In addition, analytical results from limited soil sampling conducted following 1 and 2 years of bioventing indicated substantial reductions in soil BTEX and TRPH concentrations.

Analytical results from groundwater samples collected between December 1993 and February 1994 indicate that the JP-4 releases at the Building 406 site have had minimal impact on groundwater. Although BTEX compounds were detected in five of the six wells, and TRPH was detected in one of the wells, detected concentrations were well below drinking water MCLs (Table 2.4). No free product was detected in any of the groundwater wells and was not observed in the tank removal excavations. Because these results indicate that groundwater has not been significantly impacted, and because the site is classified as a RAC-3 site, no further groundwater investigation is required. Therefore, groundwater sampling will not be performed as part of the closure sampling effort.

The pilot-scale bioventing system will operate until the Parsons ES team arrives onsite to perform the confirmation soil sampling event. The blower system will be turned off prior to the collection of soil samples. After soil sampling has been completed, the blower system will be started and reoptimized. The blower system should continue to operate until an NFRAP decision has been made and site closure has been approved by the NDEQ.

4.1 DRILLING, SAMPLING, AND EQUIPMENT DECONTAMINATION PROCEDURES

Six boreholes will be advanced and sampled in the vicinity of the former UST at the approximate locations shown on Figure 4.1. Samples will be collected at two depths (5 and 10 feet bgs) from each borehole. The locations chosen represent the locations sampled during bioventing system installation and the 1- and 2-year sampling events with the exception of VW-1 and VW-2. These locations were omitted because significant concentrations of TRPH or BTEX have not been detected at these locations during previous sampling events. Soil samples will be collected using a truck-mounted, hydraulically powered Geoprobe® percussion/probing machine capable of advancing sampling tools through unconsolidated soils. The Geoprobe® system provides for the rapid collection of soil samples at shallow depths while minimizing the generation of investigation-derived waste materials.

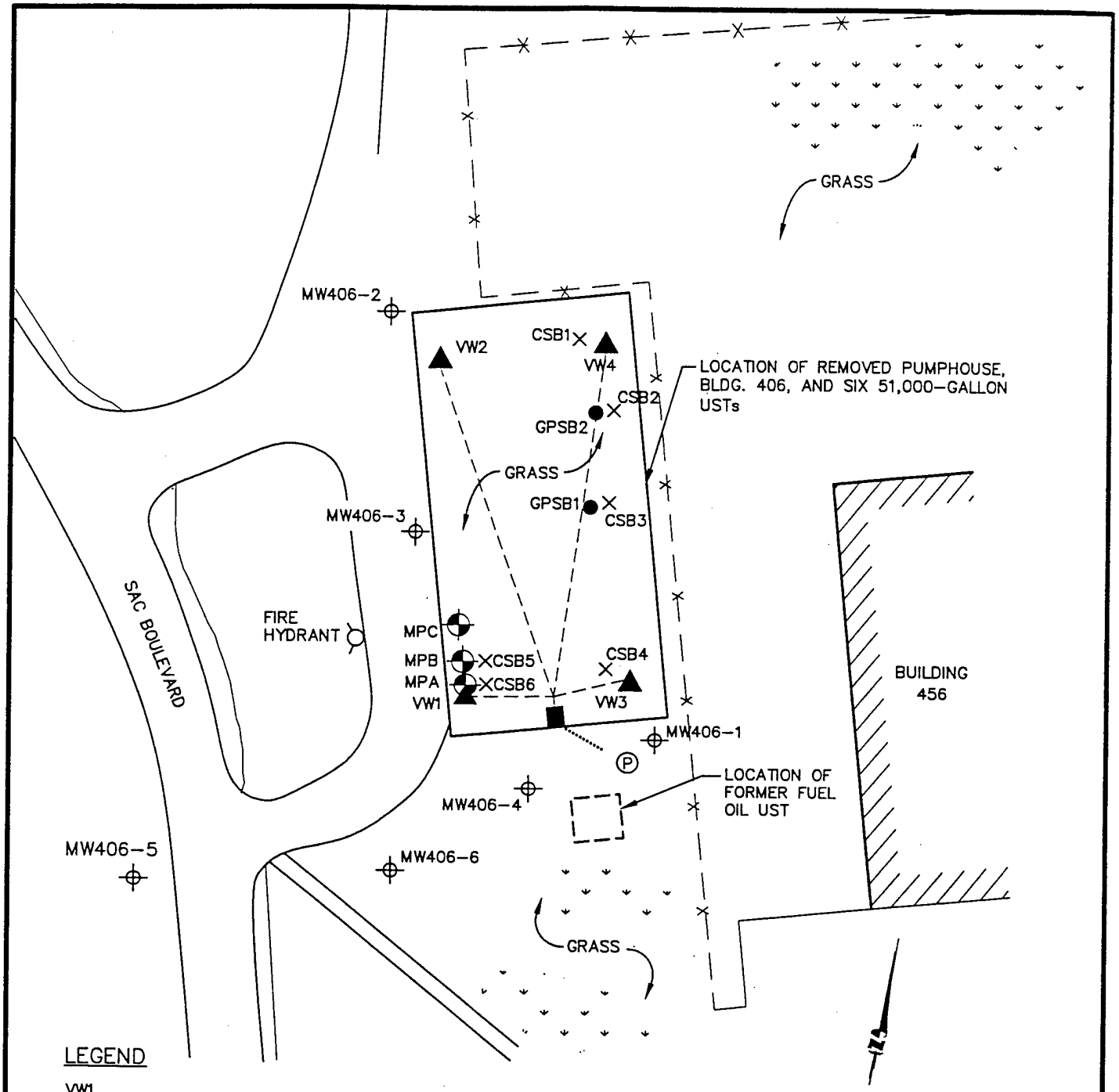


FIGURE 4.1

PROPOSED SOIL SAMPLING LOCATIONS

Building 406
Offutt Air Force Base, Nebraska

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado (303) 831-8100

K:\AFCEE\72240B\97DN0677, 09/29/97 at 15:33

Soil samples will be collected using a probe-drive sampler. The probe-drive sampler serves as both the driving point and the sample collection device and is attached to the leading end of the probe rods. To collect a soil sample, the sampler is pushed or driven to the desired sampling depth, the drive point is retracted, to open the sampling barrel, and the sampler is subsequently pushed into the undisturbed soils. The soil cores are retained within clear acetate liners inside the sampling barrel. The probe rods are then retracted, bringing the sampling device to the surface. The soil sample can then be extruded from the liners for lithologic logging, or the liners can be capped, and the undisturbed samples can be submitted to the analytical laboratory for testing. Soil samples will be screened with a PID or a total volatile hydrocarbon analyzer (TVHA).

Samplers, drive rods, and other downhole equipment will be cleaned before use and between boreholes to prevent cross-contamination. All downhole equipment will be washed with Alconox® detergent and rinsed with tap water. Between sampling events, the probe-drive sampler will be cleaned with Alconox®, followed by successive potable and distilled water rinses.

Boreholes will be drilled to 10 feet bgs. Soil samples will be collected at the 5- and 10-foot intervals at each sampling location. All soil samples will be visually examined and field analyzed using a PID or TVHA. The acetate liners containing the sample will be cut into 6-inch sections, and the ends of the sections will be screened with a PID or TVHA. The most contaminated interval of each sample, based on field screening results, will be submitted for laboratory analysis of TRPH, BTEX, and PAHs (see Section 4.2). In preparation for laboratory submittal, the ends of the selected section will be covered with Teflon® sheets and plastic end caps. The samples will be labeled with the site name and borehole number, sample depth, date of collection, project name, and other pertinent data. The samples will be sealed in plastic bags and immediately placed in an insulated cooler containing ice. The soil samples will be maintained in a chilled condition until delivered to the analytical laboratory. Chain-of-custody records will be prepared in the field and will accompany the samples to the analytical laboratory.

The remaining samples will be used for geologic logging. The data obtained from logging and headspace screening will be recorded on the borehole logs. Boreholes will be logged by a Parsons ES geologist. Soil types will be classified according to the Unified Soil Classification System (USCS) and described in accordance with the standard Parsons ES soil description format.

Following sampling, boreholes will be abandoned using granular bentonite. The granular bentonite will be placed in 3-foot lifts and hydrated to ensure complete hydration. The upper 1 foot of each borehole will be filled with excess soil sample.

4.2 SOIL SAMPLE ANALYSIS

All samples will be analyzed by an AFCEE-approved laboratory. Parsons ES proposes to analyze samples from the Building 406 site for TRPH by USEPA Method 418.1, for BTEX by USEPA Method SW8020, and for PAHs by USEPA Method SW8310. Quality control (QC) samples also will be collected and analyzed to assess

field and laboratory methods. The laboratory will perform analyses on one matrix spike and matrix spike duplicate (MS/MSD) sample for each specific analytical method requested, and one field trip blank per cooler for BTEX.

SECTION 5

SITE CONFIRMATION SAMPLING REPORT FORMAT

Following receipt of the laboratory analytical results, a draft confirmation soil sampling report will be prepared and submitted to 55 CES/CEVR and AFCEE.

The report will contain the following information for the former UST site:

- Plot plans showing final borehole locations;
- Summary of field activities;
- Assessment of analytical results in comparison to RBSLs and previous sampling results;
- Development of SSTLs for those contaminants detected at concentrations greater than the RBSLs;
- Laboratory analytical reports and chain-of-custody forms;
- Borehole logs; and
- Conclusions and recommendations for site closure or additional cleanup action.

Comments received from 55 CES/CEVR and AFCEE will be incorporated into a draft final report to be distributed to AFCEE, 55 CES/CEVR, and NDEQ.

SECTION 6

WASTE MANAGEMENT PLAN

This waste management plan applies only to the activities that will be performed for confirmation soil sampling at the Building 406 site at Offutt AFB. The investigation-derived waste (IDW) that will be generated during the confirmation sampling include both solid materials and wastewater produced from decontamination of sampling equipment.

Because the Geoprobe® system will be utilized to collect soil samples, minimal quantities of excess soil will be generated. The probe-sampling device generates no soil cuttings. The sampler is 18 inches long and 1.25 inches in diameter. Typically, 6 inches of the sample are sent to the laboratory for analysis. The remaining sample material will be used to fill the upper portion of the abandoned boreholes and/or spread on the ground surface at the site. The estimated total volume of excess soil sample is 0.01 cubic foot. Water generated during decontamination of sampling equipment also will be spread on the ground surface. An estimated 10 gallons of decontamination water will be generated.

SECTION 7

BASE SUPPORT REQUIREMENTS

The following Offutt AFB support is needed prior to the arrival of the Parsons ES sampling team:

- Assistance in obtaining drilling and digging permits;
- Arrangement of Base and site access for Parsons ES personnel; and
- Provision of a potable water supply for decontamination activities.

SECTION 8

PROJECT SCHEDULE

The following schedule is contingent upon approval of this SAP and fulfillment of Offutt AFB support requirements.

Event	Date
Submit Draft Confirmation SAP to AFCEE, 55 CES/CEVR, and NDEQ	28 July 1997
Receipt of AFCEE, 55 CES/CEVR, and NDEQ Comments	24 September 1997
Submit Final SAP to AFCEE, 55 CES/CEVR, and NDEQ	3 October 1997
Begin Confirmation Soil Sampling Field Activities	17 November 1997
Submit Draft Confirmation Soil Sampling Report to AFCEE and 55 CES/CEVR	26 January 1998
Receipt of AFCEE and 55 CES/CEVR Comments	23 February 1998
Submit Draft Final Confirmation Soil Sampling Report to AFCEE, 55 CES/CEVR, and NDEQ	16 March 1998

SECTION 9

POINTS OF CONTACT

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Nebraska Department of Environmental Quality
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Lincoln, NE 68509-2186
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Fax: (402) 471-2909

Major Ed Marchand
AFCEE/ERT
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Brooks AFB, TX 78235-5363
(210) 536-4364
Fax: (210) 536-4330

ENGINEERING-SCIENCE, INC.

Awareness Quality Improvement Process

Brian Blicker
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(406) 586-2289 (office - Fluidyne)

SECTION 10

REFERENCES CITED

Air Force Center for Environmental Excellence (AFCEE). 1996. Memorandum re: Completion of Two-Year Bioventing Test, Offutt AFB Building 406. February 25.

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ITS Intertek Testing Services
Environmental Laboratories

Case Narrative

Client: Parsons Engineering Science
Project ID: Offut AFB - Bldg 406 Project No. 726876.10221
SDG Number: D97-14995

This report contains the results of analyses completed on soil and water samples collected at Offut AFB and analyzed at Intertek Testing Services Environmental Laboratories, Dallas, Texas. The samples were analyzed in accordance with the protocols specified in the AFCEE QAPP. The following is a summary of the samples received for this SDG:

ITS Laboratory ID	Client Sample ID	Matrix	Date Collected	Date Received
D97-14995-1	OF-CSB7-5.5'	Soil	12/8/97	12/10/97
D97-14995-2	OF-CSB1-5'	Soil	12/8/97	12/10/97
D97-14995-3	OF-CSB1-10'	Soil	12/8/97	12/10/97
D97-14995-4	OF-CSB6-6'	Soil	12/8/97	12/10/97
D97-14995-5	OF-CSB6-11'	Soil	12/8/97	12/10/97
D97-14995-6	OF-CSB5-6'	Soil	12/8/97	12/10/97
D97-14995-7	OF-CSB5-10'	Soil	12/8/97	12/10/97
D97-14995-8	OF-CSB4-5'	Soil	12/9/97	12/10/97
D97-14995-9	OF-CSB4-10'	Soil	12/9/97	12/10/97
D97-14995-10	OF-CSB2-5'	Soil	12/9/97	12/10/97
D97-14995-11	OF-CSB2-10'	Soil	12/9/97	12/10/97
D97-14995-12	OF-CSB3-5'	Soil	12/9/97	12/10/97
D97-14995-13	OF-CSB3-10'	Soil	12/9/97	12/10/97
D97-14995-14	TRIP BLANK	Water		12/10/97

Note: ITS sample number D97-14995-15 through D97-14995-28 represent laboratory QC samples.

General Comments:

Except as otherwise noted, these comments apply to all analyses associated with this SDG:

1. All samples were received intact with the appropriate documentation and custody seals. Appropriate sample containers and container preservation were verified.

2. One cooler was received at the laboratory. Cooler temperatures are measured at the time of receipt using temperature blanks and a thermometer unless otherwise noted.

3 All soil samples were analyzed for percent moisture in accordance with ASTM method D2216. All analytical results were corrected for percent moisture.

4. All positive gas chromatographic results were subject to second column or second detector confirmation with the exception of diesel range organics (DRO) and gasoline range organics (GRO) analyses.

5. All method-recommended holding times were met for the sample analyses associated with this SDG.

6. Additional comments are included in the department narratives.

Departmental Narratives:

Gas Chromatography

Volatile Organics: SW-846 Method8021(BTEX)

- *Holding Times:* All holding times as specified in the method {or QAPP} were met for the samples associated with this SDG.
- *Instrument Calibration:* All initial and continuing calibration criteria as specified in the method {OR QAPP}were met for the samples associated with this SDG.
- *Method Blanks:* No target analytes were detected above the PQL for any of the method blanks associated with this SDG.
- *Laboratory Control Samples:* All Laboratory Control Sample recovery criteria as specified in the method {or QAPP} were met for the samples associated with this SDG.
- *Matrix Spike / Matrix Spike Duplicates:* The following samples were used for the Matrix Spike and Duplicate:

Laboratory Sample ID	Client Sample ID
D97-14995-18	OF4-CSB2-5' MS
D97-14995-19	OF4-CSB2-5' MSD

- All Matrix Spike / Matrix Spike Duplicate recovery and RPD criteria as specified in the method {or QAPP} were met for the samples associated with this SDG.
- *Surrogate Recoveries:* All Surrogate spike recovery criteria as specified in the method {or QAPP} were met for all samples, blanks and spikes associated with this SDG.
- *Internal Standards:* All Internal Standard criteria as specified in the method {or QAPP} were met for all samples, blanks and spikes associated with this SDG.
- *Sample Dilutions:* No sample dilutions were required, with the following exceptions:

Sample ID	Analyte	Dilution
D97-14995-1	Benzene, Ethyl Benzene	1:100
D97-14995-2	m,p-Xylene	1:250
D97-14995-8	Ethyl Benzene	1:250
D97-14995-9	Ethyl Benzene, m,p-Xylene	1:500
D97-14995-13	Benzene, Ethyl Benzene, m,p-Xylene	1:100

- *Data Qualifier Codes:* The following data qualifier codes were used :

Code	Explanation
J	Quantitation values between the MDL and the PQL are estimated concentrations.
U	Compound undetected down to MDL
D	Dilution was required on sample

- *Additional Comments:* No further observations were noted during the analysis of samples associated with this SDG.

Liquid Chromatography

PNA: SW-846 Method 8310

- *Holding Times:* All holding times as specified in the method {OR QAPP} were met for the samples associated with this SDG.

- *Instrument Calibration:* All initial and continuing calibration criteria as specified in the method {OR QAPP} were met for the samples associated with this SDG, with the following exceptions:

Date	Type (ICAL, CCV, 2nd Source)	Analyte	RSD or %D
1/19/98	CCV (CCAL2)	Indeno (1,2,3-cd) Pyrene	29.0
1/20/98	CCV (CCAL3)	Fluorene	15.5

- *Method Blanks:* No target analytes were detected above the PQL for any of the method blanks associated with this SDG.

- *Laboratory Control Samples:* All Laboratory Control Sample recovery criteria as specified in the method {or QAPP} were met for the samples associated with this SDG.

- *Matrix Spike / Matrix Spike Duplicates:* The following samples were used for the Matrix Spike and Duplicate:

Laboratory Sample ID	Client Sample ID
D97-14995-18	OF4-CSB2-5' MS
D97-14995-19	OF4-CSB2-5' MSD

- All Matrix Spike / Matrix Spike Duplicate recovery and RPD criteria as specified in the method {or QAPP} were met for the samples associated with this SDG.

- *Surrogate Recoveries:* All Surrogate spike recovery criteria as specified in the method {or QAPP} were met for all samples, blanks and spikes associated with this SDG.

- *Internal Standards:* All Internal Standard criteria as specified in the method {or QAPP} were met for all samples, blanks and spikes associated with this SDG.

- *Sample Dilutions:* No sample dilutions were required, with the following exceptions:

Sample ID	Analyte	Dilution
D97-14995-1	All Target Analytes	1:10
D97-14995-2	All Target Analytes	1:10
D97-14995-3	All Target Analytes	1:10
D97-14995-8	All Target Analytes	1:20
D97-14995-12	All Target Analytes	1:5
D97-14995-13	All Target Analytes	1:200

- *Data Qualifier Codes:* The following data qualifier codes were used :

Code	Explanation
F	Quantitation values between the MDL and the PQL are estimated concentrations.
D	Sample required dilution
U	Compound undetected down to MDL

- *Additional Comments:* No further observations were noted during the analysis of samples associated with this SDG.

Summary:

The enclosed Results of analyses are representative of the samples as received by the laboratory. ITS Environmental Laboratories (ITS) makes no representations or certifications as to the method of sample collection, sample identification or sample transportation/handling procedures utilized prior to the receipt of the samples by ITS. These data should be considered in their entirety; ITS cannot be responsible for the detachment, separation or otherwise partial use of this report. To the best of my knowledge, the information contained herein is accurate and complete. Please feel free to contact Mr. Bharat Vandra at (972) 238-5591 if you have any questions.

Approved by: _____ **Date:** 2/16/99
ITS Environmental Laboratories

Addr... 17th Road, Ste 9m
Denver, CO 80290

Contact: John Ratz
Phone: (303) 831-8100
Fax: (303) 831-8208
Contract/ Quote #:

Addres
Contact:
Phone:
PO/SO #: 726876.10221

Temp. of coolers when received (C°): 1/ 2 3 4 5
Custody Seal N Y
Intact N Y
Screened For Radioactivity ☐

Sampler's Name: DAVID TEETS
Sampler's Signature: David Teets

Proj. No.: 726876.10221
Project Name: offutt AFB - Bldg 406
No./Type of Containers²: one sleeve for each sample

Matrix¹	Date	Time	Comp	Grab	Identifying Marks of Sample(s)	VOA	A/G 1 Lt.	250 ml	P/O	TRPH by 418.1	BTEX by SW 8020	PAHs by SW 8310	Lab Sample ID (Lab Use Only)
S	12/8	1030		X	OF4-CSB7-5.5' - Dup				X	X	X	X	14995 -1
S	12/8	1130		X	OF4-CSB1-5' - Parent				X	X	X	X	2
S	12/8	1150		X	OF4-CSB1-10'				X	X	X	X	3
S	12/8	1420		X	OF4-CSB6-6'				X	X	X	X	4
S	12/8	1435		X	OF4-CSB6-11'				X	X	X	X	5
S	12/8	1455		X	OF4-CSB5-6'				X	X	X	X	6
S	12/8	1520		X	OF4-CSB5-10'				X	X	X	X	7
S	12/9	1125		X	OF4-CSB4-5'				X	X	X	X	8
S	12/9	1140		X	OF4-CSB4-10'				X	X	X	X	9
S	12/9	1325		X	OF4-CSB2-5'				X	X	X	X	10
S	12/9	1325		X	OF4-CSB2-5' MS/MSD				X	X	X	X	11
S	12/9	1335		X	OF4-CSB2-10'				X	X	X	X	12
S	12/9	1400		X	OF4-CSB3-5'				X	X	X	X	13
S	12/9	1430		X	OF4-CSB3-10'				X	X	X	X	14
W	12/9	1645			Trip Blank	X			X		X		10

Turn around time ☒ Priority 1 or Standard ☐ Priority 2 or 50% * ☐ Priority 3 or 100% * ☐ Priority 4 ERS (Dallas Only) * Must Coordinate with Project Manager

Shipment For Case Complete ☒ Yes ☐ No

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
David Teets	12/9/97	1700	FED EX		
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
				12/10/97	11:00
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:

Remarks
Option 2 (AFCEE Bioventing)
All soil samples to be analyzed for TRPH, BTEX & PAHs

Client's delivery of samples constitutes acceptance of ITS Environmental Laboratories terms and conditions contained in the Price Schedule.

¹Matrix WW - Wastewater W - Water S - Soil SD - Solid L - Liquid A - Air Bag C - Charcoal tube SL - Sludge O - Oil

²Container VOA - 40 ml vial A/G - Amber / Or Glass 1 Liter 250 ml - Glass wide mouth P/O - Plastic or other _____

ITS cannot accept verbal changes.
Please Fax written changes to
(972) 238-5592

1007

FedEx USA Airbill 802397821392 0200 FedEx Retrieval Copy

1 From 12/9/97 Sender's FedEx Account Number 167402746 (303) 831-8100
David Teets Phone 406 248-2003
Parsons ES, Inc.
1700 Broadway Ste 900
Denver CO 80290
Dept/Floor/Suite/Room State ZIP
2 726876.10221

3 To Todd Sterling / Sample Receiving Phone 972 238-5591
Intertek Testing Services
1089 E. Collins Blvd. # 100
Dept/Floor/Suite/Room
Richardson TX 75081
Check here if residence

For HOLD at FedEx Location check here
Hold Weekday Hold Saturday
For Saturday Delivery check here

4a Express Package Service Packages under 150 lbs.
X FedEx Priority Overnight 5 FedEx Standard Overnight 3 FedEx 2Day* 20 FedEx Express Saver*
FedEx First Overnight
(Higher rates apply)

4b Express Freight Service Packages over 150 lbs.
FedEx Overnight Freight 8 FedEx 2Day Freight 83 FedEx Express Saver Freight

6 Packaging 6 FedEx Letter FedEx Pak 3 FedEx Box 4 FedEx Tube 1 X Other 12/9/97

8 Special Handling
Does this shipment contain dangerous goods? 4 Yes Yes
Dry Ice CA Cargo Aircraft Only

7 Payment Obtain Recipient FedEx Account No.
Bill to: X Sender 2 Recipient 3 Third Party 4 Credit Card 5 Cash/Check
FedEx Account No.
Credit Card No. Exp. Date

Total Packages 1 Total Weight 9 Total Charges $
CONDITIONS OF CARRIAGE, DECLARED VALUE, AND LIMIT OF LIABILITY sections for further information
Credit Card Auth

8 Release Signature
287

Rev. Date 5/97
Part #150365
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GBFE 11/97

802397821392

INTERTEK TESTING SERVICES

SAMPLE RECEIVING CHECKLIST / COOLER RECEIPT

Customer: Parsons ES, Inc

Date received 12.10.97 Project 724876.10221

Login Signature: Linda Vaca Date: 12-10-97

Cooler Information:

Shipping Carrier (FedEx) DHL UPS USPS Pony Airborne Hand Other

(YES) NO Airbill Attached?

(YES) NO Custody Seals Type: Tape (COC Seals) Signed Tape

(YES) NO Seals Intact?

Cooler Temp: 4 (Ice-present) Ice-melted Ice Substitute None

(YES) NO Were Containers Intact (no leaking or broken bottles)?

(YES) NO Were sample labels intact and in good condition?

COC / Sample Information:

(YES) NO Do the sample labels agree with the COC?

(YES) NO Sufficient Sample Provided?

(YES) NO Is it clear what analysis are needed?

(YES) NO Were samples received in hold time?

VA (YES) NO Short holding parameters flagged / Lab notified

Person(s) notified: _____ time: _____

Notes: _____

_____

_____

DATE RECEIVED:	10-DEC-1997	REPORT NUMBER:	D97-14995-1
REPORT DATE:	16-FEB-1998 17:34:31.79	ID MARKS:	OF4-CSB7#
DATE SAMPLED:	8-DEC-1997	:	N1#(5.5-5.5')
PURCHASE ORDER:		PROJECT:	726876.10221 Offut AFB Bld.406
SAMPLE MATRIX:	Soil for IRPIMS		

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by MKS
Analyzed using EPA 8020A PR on 21-DEC-1997 by MKS
QC Batch No : 27-122097R
Dilution Factor : 100
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.03	0.13	4.42 mg/Kg	D
Toluene	0.03	0.25	< 0.25 mg/Kg	DU
Ethyl benzene	0.04	0.25	0.74 mg/Kg	D
m,p-Xylene	0.08	0.25	< 0.25 mg/Kg	DU
o-Xylene	0.03	0.25	< 0.25 mg/Kg	DU

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			4.50 mg/Kg	D

Applicable results are reported on dry weight basis.

2006

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-1
REPORT DATE: 16-FEB-1998 17:34:31.79	ID MARKS: OF4-CSB7#
DATE SAMPLED: 8-DEC-1997	: N1#(5.5-5.5')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by MKS
Analyzed using EPA 8020A PR on 21-DEC-1997 by MKS
QC Batch No : 27-122097R
Dilution Factor : 100
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.03	0.13	4.42 mg/Kg	D
Toluene	0.03	0.25	< 0.25 mg/Kg	DU
Ethyl benzene	0.04	0.25	0.74 mg/Kg	D
m,p-Xylene	0.08	0.25	< 0.25 mg/Kg	DU
o-Xylene	0.03	0.25	< 0.25 mg/Kg	DU

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			4.50 mg/Kg	D

Applicable results are reported on dry weight basis.

2007

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-1
REPORT DATE: 16-FEB-1998 17:34:31.79	ID MARKS: OF4-CSB7#
DATE SAMPLED: 8-DEC-1997	: N1#(5.5-5.5')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by MKS
Analyzed using EPA 8020A C2 on 26-DEC-1997 by MKS
QC Batch No : 27-122097R
Dilution Factor : 25
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.006	0.031	0.995 mg/Kg	D
Ethyl benzene	0.009	0.063	0.063 mg/Kg	DJ

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
4-Chlorofluorobenzene (SS)			0.271 mg/Kg	D

Applicable results are reported on dry weight basis.

2008

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-2
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB1#
DATE SAMPLED: 8-DEC-1997	: N1#(5.0-5.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 27-JAN-1998 by MKS
Analyzed using EPA 8020A PR on 27-JAN-1998 by MKS
QC Batch No : 27-122097R
Dilution Factor : 250
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.06	0.31	< 0.31 mg/Kg	DU
Toluene	0.06	0.62	< 0.62 mg/Kg	DU
Ethyl benzene	0.09	0.62	< 0.62 mg/Kg	DU
m,p-Xylene	0.19	0.62	12.0 mg/Kg	D
o-Xylene	0.06	0.62	< 0.62 mg/Kg	DU

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			18.1 mg/Kg	D

Applicable results are reported on dry weight basis.

ITS Intertek Testing Services
Environmental Laboratories

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-2
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB1#
DATE SAMPLED: 8-DEC-1997	: N1#(5.0-5.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 20-DEC-1997 by RFG
Analyzed using EPA 8020A C1 on 21-DEC-1997 by RFG
QC Batch No : 27-122097R
Dilution Factor : 250
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.06	0.31	< 0.31 mg/Kg	DU
Toluene	0.06	0.62	< 0.62 mg/Kg	DU
Ethyl benzene	0.09	0.62	< 0.62 mg/Kg	DU
m,p-Xylene	0.19	0.62	12.0 mg/Kg	D
o-Xylene	0.06	0.62	< 0.62 mg/Kg	DU

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			18.1 mg/Kg	D

Applicable results are reported on dry weight basis.

Intertek Testing Services NA Inc.
1089 East Collins Boulevard Richardson, TX 75081
Telephone (972) 238-5591 Fax (972) 238-5592

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-2
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB1#
DATE SAMPLED: 8-DEC-1997	: N1#(5.0-5.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 27-JAN-1997 by MKS
Analyzed using EPA 8020A C2 on 27-JAN-1997 by MKS
QC Batch No : 27-122097R
Dilution Factor : 500
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
m,p-Xylene	0.37	1.23	1.79 mg/Kg	D

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
4-Chlorofluorobenzene (SS)			5.43 mg/Kg	D

Applicable results are reported on dry weight basis.

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-3
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB1#
DATE SAMPLED: 8-DEC-1997	: N1#(10.0-10.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0003	0.0013	< 0.0013 mg/Kg	U
Toluene	0.0003	0.0026	< 0.0026 mg/Kg	U
Ethyl benzene	0.0004	0.0026	< 0.0026 mg/Kg	U
m,p-Xylene	0.0008	0.0026	< 0.0026 mg/Kg	U
o-Xylene	0.0003	0.0026	< 0.0026 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.056 mg/Kg	

Applicable results are reported on dry weight basis.

2012

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-4
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB6#
DATE SAMPLED: 8-DEC-1997	: N1#(6.0-6.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 22-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 22-DEC-1997 by RFG
QC Batch No : 27-122297R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0003	0.0013	< 0.0013 mg/Kg	U
Toluene	0.0003	0.0025	< 0.0025 mg/Kg	U
Ethyl benzene	0.0004	0.0025	< 0.0025 mg/Kg	U
m,p-Xylene	0.0007	0.0025	< 0.0025 mg/Kg	U
o-Xylene	0.0003	0.0025	< 0.0025 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.056 mg/Kg	

Applicable results are reported on dry weight basis.

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-5
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB6#
DATE SAMPLED: 8-DEC-1997	: N1#(11.0-11.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0003	0.0013	< 0.0013 mg/Kg	U
Toluene	0.0003	0.0026	< 0.0026 mg/Kg	U
Ethyl benzene	0.0004	0.0026	< 0.0026 mg/Kg	U
m,p-Xylene	0.0008	0.0026	< 0.0026 mg/Kg	U
o-Xylene	0.0003	0.0026	< 0.0026 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.060 mg/Kg	

Applicable results are reported on dry weight basis.

2014

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-6
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB5#
DATE SAMPLED: 8-DEC-1997	: N1#(6.0-6.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0003	0.0013	< 0.0013 mg/Kg	U
Toluene	0.0003	0.0026	< 0.0026 mg/Kg	U
Ethyl benzene	0.0004	0.0026	< 0.0026 mg/Kg	U
m,p-Xylene	0.0008	0.0026	< 0.0026 mg/Kg	U
o-Xylene	0.0003	0.0026	< 0.0026 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.061 mg/Kg	

Applicable results are reported on dry weight basis.

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-7
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB5#
DATE SAMPLED: 8-DEC-1997	: N1#(10.0-10.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0003	0.0013	< 0.0013 mg/Kg	U
Toluene	0.0003	0.0026	< 0.0026 mg/Kg	U
Ethyl benzene	0.0004	0.0026	< 0.0026 mg/Kg	U
m,p-Xylene	0.0008	0.0026	< 0.0026 mg/Kg	U
o-Xylene	0.0003	0.0026	< 0.0026 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.063 mg/Kg	

Applicable results are reported on dry weight basis.

2016

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-8
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB4#
DATE SAMPLED: 8-DEC-1997	: N1#(5.0-5.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.106
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 27-JAN-1998 by MKS
Analyzed using EPA 8020A PR on 27-JAN-1998 by MKS
QC Batch No : 27-122097R
Dilution Factor : 250
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.06	0.31	< 0.31 mg/Kg	DU
Toluene	0.06	0.62	< 0.62 mg/Kg	DU
Ethyl benzene	0.09	0.62	6.28 mg/Kg	D
m,p-Xylene	0.19	0.62	< 0.62 mg/Kg	DU
o-Xylene	0.06	0.62	< 0.62 mg/Kg	DU

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			19.5 mg/Kg	D

Applicable results are reported on dry weight basis.

2017

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-8
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB4#
DATE SAMPLED: 8-DEC-1997	: N1#(5.0-5.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 20-DEC-1997 by RFG
Analyzed using EPA 8020A C1 on 21-DEC-1997 by RFG
QC Batch No : 27-122097R
Dilution Factor : 250
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.06	0.31	< 0.31 mg/Kg	DU
Toluene	0.06	0.62	< 0.62 mg/Kg	DU
Ethyl benzene	0.09	0.62	6.29 mg/Kg	D
m,p-Xylene	0.19	0.62	< 0.62 mg/Kg	DU
o-Xylene	0.06	0.62	< 0.62 mg/Kg	DU

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			19.4 mg/Kg	D

Applicable results are reported on dry weight basis.

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-8
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB4#
DATE SAMPLED: 8-DEC-1997	: N1#(5.0-5.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 27-JAN-1998 by MKS
Analyzed using EPA 8020A C2 on 27-JAN-1998 by MKS
QC Batch No : 27-122097R
Dilution Factor : 500
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Ethyl benzene	0.19	1.24	1.33 mg/Kg	D

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
4-Chlorofluorobenzene (SS)			5.18 mg/Kg	D

Applicable results are reported on dry weight basis.

2019

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-9
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB4#
DATE SAMPLED: 8-DEC-1997	: N1#(10.0-10.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 20-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 20-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 500
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.13	0.63	< 0.63 mg/Kg	DU
Toluene	0.13	1.25	< 1.25 mg/Kg	DU
Ethyl benzene	0.19	1.25	5.29 mg/Kg	D
m,p-Xylene	0.38	1.25	17.5 mg/Kg	D
o-Xylene	0.13	1.25	< 1.25 mg/Kg	DU

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			39.1 mg/Kg	D

Applicable results are reported on dry weight basis.

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-9
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB4#
DATE SAMPLED: 8-DEC-1997	: N1#(10.0-10.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 20-DEC-1997 by RFG
Analyzed using EPA 8020A C1 on 20-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 500
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.13	0.63	< 0.63 mg/Kg	DU
Toluene	0.13	1.25	< 1.25 mg/Kg	DU
Ethyl benzene	0.19	1.25	5.29 mg/Kg	D
m,p-Xylene	0.38	1.25	17.5 mg/Kg	D
o-Xylene	0.13	1.25	< 1.25 mg/Kg	DU

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			39.1 mg/Kg	D

Applicable results are reported on dry weight basis.

2021

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-9
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB4#
DATE SAMPLED: 8-DEC-1997	: N1#(10.0-10.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 27-JAN-1998 by MKS
Analyzed using EPA 8020A C2 on 27-JAN-1998 by MKS
QC Batch No : 27-121997R
Dilution Factor : 500
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Ethyl benzene	0.19	1.25	7.81 mg/Kg	D
m,p-Xylene	0.38	1.25	11.6 mg/Kg	D

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
4-Chlorofluorobenzene (SS)			7.14 mg/Kg	D

Applicable results are reported on dry weight basis.

2022

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-10
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB2#
DATE SAMPLED: 9-DEC-1997	: N1#(5.0-5.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0012	< 0.0012 mg/Kg	U
Toluene	0.0002	0.0025	< 0.0025 mg/Kg	U
Ethyl benzene	0.0004	0.0025	< 0.0025 mg/Kg	U
m,p-Xylene	0.0007	0.0025	< 0.0025 mg/Kg	U
o-Xylene	0.0002	0.0025	< 0.0025 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.056 mg/Kg	

Applicable results are reported on dry weight basis.

2023

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-11
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB2#
DATE SAMPLED: 9-DEC-1997	: N1#(10.0-10.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0003	0.0013	< 0.0013 mg/Kg	U
Toluene	0.0003	0.0026	< 0.0026 mg/Kg	U
Ethyl benzene	0.0004	0.0026	< 0.0026 mg/Kg	U
m,p-Xylene	0.0008	0.0026	< 0.0026 mg/Kg	U
o-Xylene	0.0003	0.0026	0.0013 mg/Kg	J

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.060 mg/Kg	

Applicable results are reported on dry weight basis.

2024

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-12
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB3#
DATE SAMPLED: 9-DEC-1997	: N1#(5.0-5.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0012	0.0013 mg/Kg	
Toluene	0.0002	0.0024	< 0.0024 mg/Kg	U
Ethyl benzene	0.0004	0.0024	0.0445 mg/Kg	
m,p-Xylene	0.0007	0.0024	0.0566 mg/Kg	
o-Xylene	0.0002	0.0024	< 0.0024 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.060 mg/Kg	

Applicable results are reported on dry weight basis.

2025

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-12
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB3#
DATE SAMPLED: 9-DEC-1997	: N1#(5.0-5.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A C1 on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0012	0.0013 mg/Kg	
Toluene	0.0002	0.0024	< 0.0024 mg/Kg	U
Ethyl benzene	0.0004	0.0024	0.0445 mg/Kg	
m,p-Xylene	0.0007	0.0024	0.0566 mg/Kg	
o-Xylene	0.0002	0.0024	< 0.0024 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.060 mg/Kg	

Applicable results are reported on dry weight basis.

2026

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-12
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB3#
DATE SAMPLED: 9-DEC-1997	: N1#(5.0-5.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 27-JAN-1998 by MKS
Analyzed using EPA 8020A C2 on 27-JAN-1998 by MKS
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0012	0.0470 mg/Kg	
Ethyl benzene	0.0004	0.0024	0.135 mg/Kg	
m,p-Xylene	0.0007	0.0024	0.212 mg/Kg	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
4-Chlorofluorobenzene (SS)			0.161 mg/Kg	

Applicable results are reported on dry weight basis.

2027

DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-13
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB3#
DATE SAMPLED: 9-DEC-1997	: N1#(10.0-10.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 22-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 22-DEC-1997 by RFG
QC Batch No : 27-122297R
Dilution Factor : 100
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.02	0.11	0 06 mg/Kg	DJ
Toluene	0.02	0.22	< 0.22 mg/Kg	DU
Ethyl benzene	0.03	0.22	2.00 mg/Kg	D
m,p-Xylene	0.07	0.22	5.64 mg/Kg	D
o-Xylene	0.02	0.22	< 0.22 mg/Kg	DU

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			7.03 mg/Kg	D

Applicable results are reported on dry weight basis.

2028

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-13
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB3#
DATE SAMPLED: 9-DEC-1997	: N1#(10.0-10.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 22-DEC-1997 by RFG
Analyzed using EPA 8020A C1 on 22-DEC-1997 by RFG
QC Batch No : 27-122297R
Dilution Factor : 100
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.02	0.11	0.06 mg/Kg	DJ
Toluene	0.02	0.22	< 0.22 mg/Kg	DU
Ethyl benzene	0.03	0.22	2.00 mg/Kg	D
m,p-Xylene	0.07	0.22	5.63 mg/Kg	D
o-Xylene	0.02	0.22	< 0.22 mg/Kg	DU

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			7.03 mg/Kg	D

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-13
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB3#
DATE SAMPLED: 9-DEC-1997	: N1#(10.0-10.0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 27-JAN-1998 by MKS
Analyzed using EPA 8020A C2 on 27-JAN-1998 by MKS
QC Batch No : 27-122297R
Dilution Factor : 25
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Ethyl benzene	0.008	0.056	0.154 mg/Kg	D
m,p-Xylene	0.017	0.056	0.076 mg/Kg	D

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
4-Chlorofluorobenzene (SS)			0.299 mg/Kg	D

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-14
REPORT DATE: 13-FEB-1998	ID MARKS: FIELDQC#
DATE SAMPLED: 9-DEC-1997	: TB1#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Water Quality Control for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 22-DEC-1997 by CNA
Analyzed using EPA 8020A PR on 22-DEC-1997 by CNA
QC Batch No : 34122197RBN
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.17	2.00	< 2.00 µg/L	U
Toluene	0.17	2.00	< 2.00 µg/L	U
Ethyl benzene	0.22	2.00	< 2.00 µg/L	U
m,p-Xylene	0.18	2.00	< 2.00 µg/L	U
o-Xylene	0.19	2.00	< 2.00 µg/L	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			98.8 µg/L	

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-15
REPORT DATE: 13-FEB-1998	ID MARKS: LABQC#
DATE SAMPLED: 10-DEC-1997	: LB1#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil/Solid Quality Control for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0010	< 0.0010 mg/Kg	U
Toluene	0.0002	0.0020	< 0.0020 mg/Kg	U
Ethyl benzene	0.0003	0.0020	< 0.0020 mg/Kg	U
m,p-Xylene	0.0006	0.0020	< 0.0020 mg/Kg	U
o-Xylene	0.0002	0.0020	< 0.0020 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.047 mg/Kg	

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-16
REPORT DATE: 13-FEB-1998	ID MARKS: LABQC#
DATE SAMPLED: 10-DEC-1997	: BS1#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil/Solid Quality Control for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0010	0.0420 mg/Kg	
Toluene	0.0002	0.0020	0.0420 mg/Kg	
Ethyl benzene	0.0003	0.0020	0.0410 mg/Kg	
m,p-Xylene	0.0006	0.0020	0.0960 mg/Kg	
o-Xylene	0.0002	0.0020	0.0420 mg/Kg	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.047 mg/Kg	

Applicable results are reported on dry weight basis.

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DATE RECEIVED:	10-DEC-1997	REPORT NUMBER:	D97-14995-17
REPORT DATE:	13-FEB-1998	ID MARKS:	LABQC#
DATE SAMPLED:	10-DEC-1997	:	BD1#(0-0')
PURCHASE ORDER:		PROJECT.	726876.10221 Offut AFB Bld.406
SAMPLE MATRIX:	Soil/Solid Quality Control for IRPIMS		

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0010	0.0390 mg/Kg	
Toluene	0.0002	0.0020	0.0400 mg/Kg	
Ethyl benzene	0.0003	0.0020	0.0380 mg/Kg	
m,p-Xylene	0.0006	0.0020	0.0900 mg/Kg	
o-Xylene	0.0002	0.0020	0.0400 mg/Kg	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.047 mg/Kg	

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-18
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB2#
DATE SAMPLED: 9-DEC-1997	: MS1#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0003	0.0013	0.0478 mg/Kg	
Toluene	0.0003	0.0026	0.0478 mg/Kg	
Ethyl benzene	0.0004	0.0026	0.0465 mg/Kg	
m,p-Xylene	0.0008	0.0026	0.109 mg/Kg	
o-Xylene	0.0003	0.0026	0.0478 mg/Kg	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.062 mg/Kg	

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-19
REPORT DATE: 13-FEB-1998	ID MARKS: OF4-CSB2#
DATE SAMPLED: 9-DEC-1997	: SD1#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 19-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 19-DEC-1997 by RFG
QC Batch No : 27-121997R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0003	0.0013	0.0517 mg/Kg	
Toluene	0.0003	0.0026	0.0504 mg/Kg	
Ethyl benzene	0.0004	0.0026	0.0504 mg/Kg	
m,p-Xylene	0.0008	0.0026	0.114 mg/Kg	
o-Xylene	0.0003	0.0026	0.0517 mg/Kg	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.062 mg/Kg	

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-20
REPORT DATE: 13-FEB-1998	ID MARKS: LABQC#
DATE SAMPLED: 10-DEC-1997	: LB1#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Water Quality Control for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 22-DEC-1997 by CNA
Analyzed using EPA 8020A PR on 22-DEC-1997 by CNA
QC Batch No : 34122197RBN
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.17	2.00	< 2.00 µg/L	U
Toluene	0.17	2.00	< 2.00 µg/L	U
Ethyl benzene	0.22	2.00	< 2.00 µg/L	U
m,p-Xylene	0.18	2.00	< 2.00 µg/L	U
o-Xylene	0.19	2.00	< 2.00 µg/L	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			97.8 µg/L	

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-21
REPORT DATE: 13-FEB-1998	ID MARKS: LABQC#
DATE SAMPLED: 10-DEC-1997	: BS1#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Water Quality Control for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 21-DEC-1997 by CNA
Analyzed using EPA 8020A PR on 21-DEC-1997 by CNA
QC Batch No : 34122197RBN
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.17	2.00	51.8 µg/L	
Toluene	0.17	2.00	52.6 µg/L	
Ethyl benzene	0.22	2.00	51.8 µg/L	
m,p-Xylene	0.18	2.00	111 µg/L	
o-Xylene	0.19	2.00	53.2 µg/L	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			96.8 µg/L	

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-22
REPORT DATE: 13-FEB-1998	ID MARKS: LABQC#
DATE SAMPLED: 10-DEC-1997	: BD1#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Water Quality Control for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 21-DEC-1997 by CNA
Analyzed using EPA 8020A PR on 21-DEC-1997 by CNA
QC Batch No : 34122197RBN
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.17	2.00	51.0 µg/L	
Toluene	0.17	2.00	51.1 µg/L	
Ethyl benzene	0.22	2.00	49.7 µg/L	
m,p-Xylene	0.18	2.00	106 µg/L	
o-Xylene	0.19	2.00	50.1 µg/L	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			95.4 µg/L	

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-23
REPORT DATE: 13-FEB-1998	ID MARKS: LABQC
DATE SAMPLED: 21-JAN-1998	: LB2#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil/Solid Quality Control for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 20-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 20-DEC-1997 by RFG
QC Batch No : 27-122097R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0010	< 0.0010 mg/Kg	U
Toluene	0.0002	0.0020	< 0.0020 mg/Kg	U
Ethyl benzene	0.0003	0.0020	< 0.0020 mg/Kg	U
m,p-Xylene	0.0006	0.0020	< 0.0020 mg/Kg	U
o-Xylene	0.0002	0.0020	< 0.0020 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.047 mg/Kg	

Applicable results are reported on dry weight basis.

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DATE RECEIVED:	10-DEC-1997	REPORT NUMBER:	D97-14995-24
REPORT DATE:	13-FEB-1998	ID MARKS:	LABQC
DATE SAMPLED:	21-JAN-1998	:	BS2#(0-0')
PURCHASE ORDER:		PROJECT:	726876.10221 Offut AFB Bld.406
SAMPLE MATRIX:	Soil/Solid Quality Control for IRPIMS		

BTEX ANALYSIS /1
Prepared using EPA 5030 on 20-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 20-DEC-1997 by RFG
QC Batch No : 27-122097R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0010	0.0460 mg/Kg	
Toluene	0.0002	0.0020	0.0460 mg/Kg	
Ethyl benzene	0.0003	0.0020	0.0450 mg/Kg	
m,p-Xylene	0.0006	0.0020	0.105 mg/Kg	
o-Xylene	0.0002	0.0020	0.0460 mg/Kg	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.048 mg/Kg	

Applicable results are reported on dry weight basis.

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DATE RECEIVED:	10-DEC-1997	REPORT NUMBER:	D97-14995-25
REPORT DATE:	13-FEB-1998	ID MARKS:	LABQC
DATE SAMPLED:	21-JAN-1998	:	BD2#(0-0')
PURCHASE ORDER:		PROJECT:	726876.10221 Offut AFB Bld.406
SAMPLE MATRIX:	Soil/Solid Quality Control for IRPIMS		

BTEX ANALYSIS /1
Prepared using EPA 5030 on 20-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 20-DEC-1997 by RFG
QC Batch No : 27-122097R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0010	0.0450 mg/Kg	
Toluene	0.0002	0.0020	0.0450 mg/Kg	
Ethyl benzene	0.0003	0.0020	0.0440 mg/Kg	
m,p-Xylene	0.0006	0.0020	0.103 mg/Kg	
o-Xylene	0.0002	0.0020	0.0450 mg/Kg	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.047 mg/Kg	

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-26
REPORT DATE: 13-FEB-1998	ID MARKS: LABQC#
DATE SAMPLED: 22-JAN-1998	: LB3#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil/Solid Quality Control for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 22-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 22-DEC-1997 by RFG
QC Batch No : 27-122297R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0010	< 0.0010 mg/Kg	U
Toluene	0.0002	0.0020	< 0.0020 mg/Kg	U
Ethyl benzene	0.0003	0.0020	< 0.0020 mg/Kg	U
m,p-Xylene	0.0006	0.0020	< 0.0020 mg/Kg	U
o-Xylene	0.0002	0.0020	< 0.0020 mg/Kg	U

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.049 mg/Kg	

Applicable results are reported on dry weight basis.

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DATE RECEIVED: 10-DEC-1997	REPORT NUMBER: D97-14995-27
REPORT DATE: 13-FEB-1998	ID MARKS: LABQC#
DATE SAMPLED: 22-JAN-1998	: BS3#(0-0')
PURCHASE ORDER:	PROJECT: 726876.10221 Offut AFB Bld.406
SAMPLE MATRIX: Soil/Solid Quality Control for IRPIMS	

BTEX ANALYSIS /1
Prepared using EPA 5030 on 22-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 22-DEC-1997 by RFG
QC Batch No : 27-122297R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0010	0.0460 mg/Kg	
Toluene	0.0002	0.0020	0.0450 mg/Kg	
Ethyl benzene	0.0003	0.0020	0.0430 mg/Kg	
m,p-Xylene	0.0006	0.0020	0.101 mg/Kg	
o-Xylene	0.0002	0.0020	0.0450 mg/Kg	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.049 mg/Kg	

Applicable results are reported on dry weight basis.

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DATE RECEIVED:	10-DEC-1997	REPORT NUMBER:	D97-14995-28
REPORT DATE:	13-FEB-1998	ID MARKS:	LABQC#
DATE SAMPLED:	22-JAN-1998	:	BD3#(0-0')
PURCHASE ORDER:		PROJECT:	726876.10221 Offut AFB Bld.406
SAMPLE MATRIX:	Soil/Solid Quality Control for IRPIMS		

BTEX ANALYSIS /1
Prepared using EPA 5030 on 23-DEC-1997 by RFG
Analyzed using EPA 8020A PR on 23-DEC-1997 by RFG
QC Batch No : 27-122297R
Dilution Factor : 1
Method Factor : 1

TEST REQUESTED	MDL	REPORTING LIMIT	RESULTS	FLAG
Benzene	0.0002	0.0010	0.0460 mg/Kg	
Toluene	0.0002	0.0020	0.0450 mg/Kg	
Ethyl benzene	0.0003	0.0020	0.0460 mg/Kg	
m,p-Xylene	0.0006	0.0020	0.113 mg/Kg	
o-Xylene	0.0002	0.0020	0.0480 mg/Kg	

BTEX ANALYSIS /1

SURROGATE COMPOUND			SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)			0.055 mg/Kg	

Applicable results are reported on dry weight basis.

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ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB7 N1 Lab Sample ID: D97-14995-1 Matrix: Soil

% Solids: 79.9 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.08880	15.0000	0.08880	10	U
Acenaphthylene	0.37500	19.3000	0.37500	10	U
Anthracene	0.01380	5.5000	0.14600	10	F
Benzo(a)anthracene	0.01750	0.1130	0.67200	10	
Benzo(a)pyrene	0.02250	0.1880	1.14000	10	
Benzo(b)fluoranthene	0.02750	0.1500	0.99100	10	
Benzo(g,h,i)perylene	0.03130	0.6260	0.49900	10	F
Benzo(k)fluoranthene	0.03000	0.1380	0.70100	10	
Chrysene	0.02000	1.2500	1.43000	10	
Dibenz(a,h)anthracene	0.06510	0.2500	0.31400	10	
Fluoranthene	0.08880	1.7500	2.19000	10	
Fluorene	0.06260	1.7500	0.06260	10	U
Indeno(1,2,3-cd)pyrene	0.03000	0.3750	0.42800	10	
Naphthalene	0.16300	15.0000	0.16300	10	U
Phenanthrene	0.02880	0.5250	0.56300	10	
Pyrene	0.07010	2.2500	2.26000	10	

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	92.2	22.0 - 167	

Comments:

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C1 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB7 N1 Lab Sample ID: D97-14995-1 Matrix: Soil

% Solids: 79.9 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.01750	0.1130	0.67200	10	
Benzo(a)pyrene	0.02250	0.1880	1.14000	10	
Benzo(b)fluoranthene	0.02750	0.1500	0.99100	10	
Benzo(k)fluoranthene	0.03000	0.1380	0.70100	10	
Chrysene	0.02000	1.2500	1.43000	10	
Dibenz(a,h)anthracene	0.06510	0.2500	0.31400	10	
Fluoranthene	0.08880	1.7500	2.19000	10	
Indeno(1,2,3-cd)pyrene	0.03000	0.3750	0.42800	10	
Pyrene	0.07010	2.2500	2.26000	10	

Comments:

3004

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C2 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB7 N1 Lab Sample ID: D97-14995-1 Matrix: Soil

% Solids: 79.9 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.01750	0.1130	0.85800	10	
Benzo(a)pyrene	0.02250	0.1880	0.89200	10	
Benzo(b)fluoranthene	0.02750	0.1500	1.31000	10	
Benzo(k)fluoranthene	0.03000	0.1380	0.39200	10	
Chrysene	0.02000	1.2500	1.43000	10	
Dibenz(a,h)anthracene	0.06510	0.2500	1.44000	10	
Fluoranthene	0.08880	1.7500	1.26000	10	F
Indeno(1,2,3-cd)pyrene	0.03000	0.3750	0.94200	10	
Pyrene	0.07010	2.2500	1.00000	10	F

Comments:

3004 A

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB1 N1 Lab Sample ID: D97-14995-2 Matrix: Soil

% Solids: 81.0 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.08760	14.8000	0.08760	10	U
Acenaphthylene	0.37000	19.0000	0.37000	10	U
Anthracene	0.01360	5.4300	0.17800	10	F
Benzo(a)anthracene	0.01730	0.1110	0.20700	10	
Benzo(a)pyrene	0.02220	0.1850	0.29700	10	
Benzo(b)fluoranthene	0.02710	0.1480	0.20200	10	
Benzo(g,h,i)perylene	0.03080	0.6170	0.09460	10	F
Benzo(k)fluoranthene	0.02960	0.1360	0.15400	10	
Chrysene	0.01970	1.2300	0.79100	10	F
Dibenz(a,h)anthracene	0.06420	0.2470	0.06420	10	U
Fluoranthene	0.08760	1.7300	1.76000	10	
Fluorene	0.06170	1.7300	0.15200	10	F
Indeno(1,2,3-cd)pyrene	0.02960	0.3700	0.09880	10	F
Naphthalene	0.16000	14.8000	0.16000	10	U
Phenanthrene	0.02840	0.5180	0.83400	10	
Pyrene	0.06910	2.2200	0.51100	10	F

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	172.0	22.0 - 167	

Comments:

AFCEE FORM O-2

3005

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C1 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB1 N1 Lab Sample ID: D97-14995-2 Matrix: Soil

% Solids: 81.0 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.01730	0.1110	0.20700	10	
Benzo(a)pyrene	0.02220	0.1850	0.29700	10	
Benzo(b)fluoranthene	0.02710	0.1480	0.20200	10	
Benzo(k)fluoranthene	0.02960	0.1360	0.15400	10	
Fluoranthene	0.08760	1.7300	1.76000	10	

Comments:

3006

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C2 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB1 N1 Lab Sample ID: D97-14995-2 Matrix: Soil

% Solids: 81.0 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.01730	0.1110	0.28000	10	
Benzo(a)pyrene	0.02220	0.1850	0.23200	10	
Benzo(b)fluoranthene	0.02710	0.1480	0.29900	10	
Benzo(k)fluoranthene	0.02960	0.1360	0.09440	10	F
Fluoranthene	0.08760	1.7300	0.79100	10	F

Comments:

3006 A

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB1 N1 Lab Sample ID: D97-14995-3 Matrix: Soil

% Solids: 76.6 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.09270	15.7000	0.09270	10	U
Acenaphthylene	0.39200	20.1000	0.39200	10	U
Anthracene	0.01440	5.7400	0.19100	10	F
Benzo(a)anthracene	0.01830	0.1170	0.23900	10	
Benzo(a)pyrene	0.02350	0.1960	0.21100	10	
Benzo(b)fluoranthene	0.02870	0.1570	0.13400	10	F
Benzo(g,h,i)perylene	0.03260	0.6530	0.04050	10	F
Benzo(k)fluoranthene	0.03130	0.1440	0.11200	10	F
Chrysene	0.02090	1.3100	2.22000	10	
Dibenz(a,h)anthracene	0.06790	0.2610	0.06790	10	U
Fluoranthene	0.09270	1.8300	1.92000	10	
Fluorene	0.06530	1.8300	0.06530	10	U
Indeno(1,2,3-cd)pyrene	0.03130	0.3920	0.03250	10	F
Naphthalene	0.17000	15.7000	0.17000	10	U
Phenanthrene	0.03000	0.5480	0.53400	10	F
Pyrene	0.07310	2.3500	1.93000	10	F

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	128.0	22.0 - 167	

Comments:

3007

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C1 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB1 N1 Lab Sample ID: D97-14995-3 Matrix: Soil

% Solids: 76.6 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.01830	0.1170	0.23900	10	
Benzo(a)pyrene	0.02350	0.1960	0.21100	10	
Chrysene	0.02090	1.3100	2.22000	10	
Fluoranthene	0.09270	1.8300	1.92000	10	

Comments:

3008

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C2 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CS31 N1 Lab Sample ID: D97-14995-3 Matrix: Soil

% Solids: 76.6 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.01830	0.1170	0.07220	10	F
Benzo(a)pyrene	0.02350	0.1960	0.16400	10	F
Chrysene	0.02090	1.3100	0.36900	10	F
Fluoranthene	0.09270	1.8300	0.86000	10	F

Comments:

3008A

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB6 N1 Lab Sample ID: D97-14995-4 Matrix: Soil

% Solids: 80.1 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.00887	1.5000	0.00887	1	U
Acenaphthylene	0.03750	1.9200	0.03750	1	U
Anthracene	0.00137	0.5500	0.00137	1	U
Benzo(a)anthracene	0.00175	0.0112	0.00175	1	U
Benzo(a)pyrene	0.00225	0.0187	0.00271	1	F
Benzo(b)fluoranthene	0.00275	0.0150	0.00468	1	F
Benzo(g,h,i)perylene	0.00312	0.0625	0.00312	1	U
Benzo(k)fluoranthene	0.00300	0.0137	0.00300	1	U
Chrysene	0.00200	0.1250	0.00200	1	U
Dibenz(a,h)anthracene	0.00650	0.0250	0.00650	1	U
Fluoranthene	0.00887	0.1750	0.01230	1	F
Fluorene	0.00625	0.1750	0.00625	1	U
Indeno(1,2,3-cd)pyrene	0.00300	0.0375	0.00300	1	U
Naphthalene	0.01620	1.5000	0.01620	1	U
Phenanthrene	0.00287	0.0525	0.00287	1	U
Pyrene	0.00699	0.2250	0.09010	1	F

Comments:

3008A

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C1 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB6 N1 Lab Sample ID: D97-14995-4 Matrix: Soil

% Solids: 80.1 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)pyrene	0.00225	0.0187	0.00271	1	F
Benzo(b)fluoranthene	0.00275	0.0150	0.00468	1	F
Chrysene	0.00200	0.1250	0.04420	1	F
Fluoranthene	0.00887	0.1750	0.01230	1	F
Pyrene	0.00699	0.2250	0.09010	1	F

Comments:

3008B

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C2 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB6 N1 Lab Sample ID: D97-14995-4 Matrix: Soil

% Solids: 80.1 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)pyrene	0.00225	0.0187	0.00366	1	F
Benzo(b)fluoranthene	0.00275	0.0150	0.00616	1	F
Chrysene	0.00200	0.1250	0.00397	1	F
Fluoranthene	0.00887	0.1750	0.00887	1	U
Pyrene	0.00699	0.2250	0.03020	1	F

Comments:

3008C

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB6 N1 Lab Sample ID: D97-14995-5 Matrix: Soil

% Solids: 78.0 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.00910	1.5400	0.00910	1	U
Acenaphthylene	0.03840	1.9700	0.03840	1	U
Anthracene	0.00141	0.5640	0.00141	1	U
Benzo(a)anthracene	0.00179	0.0115	0.00179	1	U
Benzo(a)pyrene	0.00231	0.0192	0.00231	1	U
Benzo(b)fluoranthene	0.00282	0.0154	0.00282	1	U
Benzo(g,h,i)perylene	0.00320	0.0641	0.00320	1	U
Benzo(k)fluoranthene	0.00308	0.0141	0.00308	1	U
Chrysene	0.00205	0.1280	0.00205	1	U
Dibenz(a,h)anthracene	0.00666	0.0256	0.00666	1	U
Fluoranthene	0.00910	0.1790	0.00910	1	U
Fluorene	0.00641	0.1790	0.00641	1	U
Indeno(1,2,3-cd)pyrene	0.00308	0.0384	0.00308	1	U
Naphthalene	0.01670	1.5400	0.01670	1	U
Phenanthrene	0.00295	0.0538	0.00295	1	U
Pyrene	0.00718	0.2310	0.00718	1	U

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	125.0	22.0 - 167	

Comments:

3006 D

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB5 N1 Lab Sample ID: D97-14995-6 Matrix: Soil

% Solids: 77.4 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 19-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.00917	1.5500	0.00917	1	U
Acenaphthylene	0.03880	1.9900	0.03880	1	U
Anthracene	0.00142	0.5680	0.00142	1	U
Benzo(a)anthracene	0.00181	0.0116	0.00181	1	U
Benzo(a)pyrene	0.00233	0.0194	0.00233	1	U
Benzo(b)fluoranthene	0.00284	0.0155	0.00284	1	U
Benzo(g,h,i)perylene	0.00323	0.0646	0.00323	1	U
Benzo(k)fluoranthene	0.00310	0.0142	0.00310	1	U
Chrysene	0.00207	0.1290	0.00207	1	U
Dibenz(a,h)anthracene	0.00672	0.0258	0.00672	1	U
Fluoranthene	0.00917	0.1810	0.00917	1	U
Fluorene	0.00646	0.1810	0.00646	1	U
Indeno(1,2,3-cd)pyrene	0.00310	0.0388	0.00310	1	U
Naphthalene	0.01680	1.5500	0.01680	1	U
Phenanthrene	0.00297	0.0543	0.00297	1	U
Pyrene	0.00723	0.2330	0.00723	1	U

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	131.0	22.0 - 167	

Comments:

3003 E

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB5 N1 Lab Sample ID: D97-14995-7 Matrix: Soil

% Solids: 75.7 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.00938	1.5900	0.00938	1	U
Acenaphthylene	0.03960	2.0300	0.03960	1	U
Anthracene	0.00145	0.5810	0.00145	1	U
Benzo(a)anthracene	0.00185	0.0119	0.00185	1	U
Benzo(a)pyrene	0.00238	0.0198	0.00238	1	U
Benzo(b)fluoranthene	0.00291	0.0159	0.00291	1	U
Benzo(g,h,i)perylene	0.00330	0.0661	0.00330	1	U
Benzo(k)fluoranthene	0.00317	0.0145	0.00317	1	U
Chrysene	0.00211	0.1320	0.00211	1	U
Dibenz(a,h)anthracene	0.00687	0.0264	0.00687	1	U
Fluoranthene	0.00938	0.1850	0.00938	1	U
Fluorene	0.00661	0.1850	0.00661	1	U
Indeno(1,2,3-cd)pyrene	0.00317	0.0396	0.00317	1	U
Naphthalene	0.01720	1.5900	0.01720	1	U
Phenanthrene	0.00304	0.0555	0.00304	1	U
Pyrene	0.00740	0.2380	0.00740	1	U

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	120.0	22.0 - 167	

Comments:

3006 F

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB4 N1 Lab Sample ID: D97-14995-8 Matrix: Soil

% Solids: 80.3 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.17700	29.9000	0.17700	20	U
Acenaphthylene	0.74700	38.3000	0.74700	20	U
Anthracene	0.02740	11.0000	0.50400	20	F
Benzo(a)anthracene	0.03490	0.2240	0.76400	20	
Benzo(a)pyrene	0.04480	0.3730	0.92000	20	
Benzo(b)fluoranthene	0.05480	0.2990	0.68200	20	
Benzo(g,h,i)perylene	0.06220	1.2400	0.25800	20	F
Benzo(k)fluoranthene	0.05980	0.2740	0.42800	20	
Chrysene	0.03980	2.4900	1.47000	20	F
Dibenz(a,h)anthracene	0.12900	0.4980	0.18400	20	F
Fluoranthene	0.17700	3.4900	4.78000	20	
Fluorene	0.12400	3.4900	0.33700	20	F
Indeno(1,2,3-cd)pyrene	0.05980	0.7470	0.25900	20	F
Naphthalene	0.32400	29.9000	0.32400	20	U
Phenanthrene	0.05730	1.0500	2.05000	20	
Pyrene	0.13900	4.4800	4.59000	20	

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	59.3	22.0 - 167	

Comments:

3009

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C1 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB4 N1 Lab Sample ID: D97-14995-8 Matrix: Soil

% Solids: 80.3 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.03490	0.2240	0.76400	20	
Benzo(a)pyrene	0.04480	0.3730	0.92000	20	
Benzo(b)fluoranthene	0.05480	0.2990	0.68200	20	
Benzo(k)fluoranthene	0.05980	0.2740	0.42800	20	
Fluoranthene	0.17700	3.4900	4.78000	20	
Phenanthrene	0.05730	1.0500	2.05000	20	
Pyrene	0.13900	4.4800	4.59000	20	

Comments:

3010

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C2 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB4 N1 Lab Sample ID: D97-14995-8 Matrix: Soil

% Solids: 80.3 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.03490	0.2240	0.62000	20	
Benzo(a)pyrene	0.04480	0.3730	0.92700	20	
Benzo(b)fluoranthene	0.05480	0.2990	0.97400	20	
Benzo(k)fluoranthene	0.05980	0.2740	0.30700	20	
Fluoranthene	0.17700	3.4900	2.50000	20	F
Phenanthrene	0.05730	1.0500	1.90000	20	
Pyrene	0.13900	4.4800	1.73000	20	F

Comments:

3010A

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB4 N1 Lab Sample ID: D97-14995-9 Matrix: Soil

% Solids: 80.0 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	1.78000	300.0000	1.78000	200	U
Acenaphthylene	7.50000	385.0000	7.50000	200	U
Anthracene	0.27500	110.0000	7.66000	200	F
Benzo(a)anthracene	0.35000	2.2500	31.00000	200	
Benzo(a)pyrene	0.45000	3.7500	65.50000	200	
Benzo(b)fluoranthene	0.55000	3.0000	51.10000	200	
Benzo(g,h,i)perylene	0.62500	12.5000	27.50000	200	
Benzo(k)fluoranthene	0.60000	2.7500	32.00000	200	
Chrysene	0.40000	25.0000	51.40000	200	
Dibenz(a,h)anthracene	1.30000	5.0000	20.40000	200	
Fluoranthene	1.78000	35.0000	53.10000	200	
Fluorene	1.25000	35.0000	1.25000	200	U
Indeno(1,2,3-cd)pyrene	0.60000	7.5000	25.50000	200	
Naphthalene	3.25000	300.0000	3.25000	200	U
Phenanthrene	0.57500	10.5000	18.30000	200	
Pyrene	1.40000	45.0000	57.50000	200	

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	0.0	22.0 - 167	

Comments:

3011

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C1 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB4 N1 Lab Sample ID: D97-14995-9 Matrix: Soil

% Solids: 80.0 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.35000	2.2500	31.00000	200	
Benzo(a)pyrene	0.45000	3.7500	65.50000	200	
Benzo(b)fluoranthene	0.55000	3.0000	51.10000	200	
Benzo(g,h,i)perylene	0.62500	12.5000	27.50000	200	
Benzo(k)fluoranthene	0.60000	2.7500	32.00000	200	
Chrysene	0.40000	25.0000	51.40000	200	
Dibenz(a,h)anthracene	1.30000	5.0000	20.40000	200	
Fluoranthene	1.78000	35.0000	53.10000	200	
Indeno(1,2,3-cd)pyrene	0.60000	7.5000	25.50000	200	
Pyrene	1.40000	45.0000	57.50000	200	

Comments:

3011A

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C2 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB4 N1 Lab Sample ID: D97-14995-9 Matrix: Soil

% Solids: 80.0 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.35000	2.2500	33.00000	200	
Benzo(a)pyrene	0.45000	3.7500	67.10000	200	
Benzo(b)fluoranthene	0.55000	3.0000	74.10000	200	
Benzo(g,h,i)perylene	0.62500	12.5000	53.90000	200	
Benzo(k)fluoranthene	0.60000	2.7500	21.10000	200	
Chrysene	0.40000	25.0000	66.30000	200	
Dibenz(a,h)anthracene	1.30000	5.0000	141.00000	200	
Fluoranthene	1.78000	35.0000	43.80000	200	
Indeno(1,2,3-cd)pyrene	0.60000	7.5000	76.50000	200	
Pyrene	1.40000	45.0000	97.00000	200	

Comments:

3011 B

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB2 N1 Lab Sample ID: D97-14995-10 Matrix: Soil

% Solids: 81.8 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.00868	1.4700	0.00868	1	U
Acenaphthylene	0.03670	1.8800	0.03670	1	U
Anthracene	0.00134	0.5380	0.00134	1	U
Benzo(a)anthracene	0.00171	0.0110	0.00171	1	U
Benzo(a)pyrene	0.00220	0.0183	0.00220	1	U
Benzo(b)fluoranthene	0.00269	0.0147	0.00269	1	U
Benzo(g,h,i)perylene	0.00306	0.0611	0.00306	1	U
Benzo(k)fluoranthene	0.00293	0.0134	0.00293	1	U
Chrysene	0.00196	0.1220	0.00196	1	U
Dibenz(a,h)anthracene	0.00636	0.0245	0.00636	1	U
Fluoranthene	0.00868	0.1710	0.00868	1	U
Fluorene	0.00611	0.1710	0.00611	1	U
Indeno(1,2,3-cd)pyrene	0.00293	0.0367	0.00293	1	U
Naphthalene	0.01590	1.4700	0.01590	1	U
Phenanthrene	0.00281	0.0513	0.00281	1	U
Pyrene	0.00685	0.2200	0.00685	1	U

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	122.0	22.0 - 167	

Comments:

3011C

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB2 N1 Lab Sample ID: D97-14995-11 Matrix: Soil

% Solids: 78.3 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.00906	1.5300	0.00906	1	U
Acenaphthylene	0.03830	1.9700	0.03830	1	U
Anthracene	0.00140	0.5620	0.00140	1	U
Benzo(a)anthracene	0.00179	0.0115	0.00179	1	U
Benzo(a)pyrene	0.00230	0.0191	0.00230	1	U
Benzo(b)fluoranthene	0.00281	0.0153	0.00281	1	U
Benzo(g,h,i)perylene	0.00319	0.0638	0.00319	1	U
Benzo(k)fluoranthene	0.00306	0.0140	0.00306	1	U
Chrysene	0.00204	0.1280	0.00204	1	U
Dibenz(a,h)anthracene	0.00664	0.0255	0.00664	1	U
Fluoranthene	0.00906	0.1790	0.00906	1	U
Fluorene	0.00638	0.1790	0.00638	1	U
Indeno(1,2,3-cd)pyrene	0.00306	0.0383	0.00306	1	U
Naphthalene	0.01660	1.5300	0.01660	1	U
Phenanthrene	0.00294	0.0536	0.00294	1	U
Pyrene	0.00715	0.2300	0.00715	1	U

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	119.0	22.0 - 167	

Comments:

3011 D

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB3 N1 Lab Sample ID: D97-14995-12 Matrix: Soil

% Solids: 83.1 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	0.04270	7.2200	0.91500	5	F
Acenaphthylene	0.18100	9.2700	0.18100	5	U
Anthracene	0.00662	2.6500	0.13600	5	F
Benzo(a)anthracene	0.00843	0.0542	0.29500	5	
Benzo(a)pyrene	0.01080	0.0903	0.45300	5	
Benzo(b)fluoranthene	0.01320	0.0722	0.39000	5	
Benzo(g,h,i)perylene	0.01510	0.3010	0.21900	5	F
Benzo(k)fluoranthene	0.01440	0.0662	0.28100	5	
Chrysene	0.00963	0.6020	0.46700	5	F
Dibenz(a,h)anthracene	0.03130	0.1200	0.16900	5	
Fluoranthene	0.04270	0.8430	1.14000	5	
Fluorene	0.03010	0.8430	0.17900	5	F
Indeno(1,2,3-cd)pyrene	0.01440	0.1810	0.20600	5	
Naphthalene	0.07830	7.2200	0.07830	5	U
Phenanthrene	0.01380	0.2530	0.57200	5	
Pyrene	0.03370	1.0800	1.13000	5	

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	139.0	22.0 - 167	

Comments:

3012

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C1 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB3 N1 Lab Sample ID: D97-14995-12 Matrix: Soil

% Solids: 83.1 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.00843	0.0542	0.29500	5	
Benzo(a)pyrene	0.01080	0.0903	0.45300	5	
Benzo(b)fluoranthene	0.01320	0.0722	0.39000	5	
Benzo(k)fluoranthene	0.01440	0.0662	0.28100	5	
Chrysene	0.00963	0.6020	0.46700	5	F
Dibenz(a,h)anthracene	0.03130	0.1200	0.16900	5	
Indeno(1,2,3-cd)pyrene	0.01440	0.1810	0.20600	5	
Pyrene	0.03370	1.0800	1.13000	5	

Comments:

3013

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C2 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB3 N1 Lab Sample ID: D97-14995-12 Matrix: Soil

% Solids: 83.1 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.00843	0.0542	0.26400	5	
Benzo(a)pyrene	0.01080	0.0903	0.37000	5	
Benzo(b)fluoranthene	0.01320	0.0722	0.51700	5	
Benzo(k)fluoranthene	0.01440	0.0662	0.14800	5	
Dibenz(a,h)anthracene	0.03130	0.1200	0.65600	5	
Indeno(1,2,3-cd)pyrene	0.01440	0.1810	0.17600	5	F
Pyrene	0.03370	1.0800	0.52700	5	F

Comments:

3013A

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 PR Preparatory Method: EPA 3550B AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB3 N1 Lab Sample ID: D97-14995-13 Matrix: Soil

% Solids: 89.7 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Acenaphthene	1.58000	268.0000	1.58000	200	U
Acenaphthylene	6.69000	343.0000	6.69000	200	U
Anthracene	0.24500	98.1000	5.45000	200	F
Benzo(a)anthracene	0.31200	2.0100	10.80000	200	
Benzo(a)pyrene	0.40100	3.3500	17.70000	200	
Benzo(b)fluoranthene	0.49100	2.6800	14.90000	200	
Benzo(g,h,i)perylene	0.55800	11.2000	7.83000	200	F
Benzo(k)fluoranthene	0.53500	2.4500	9.76000	200	
Chrysene	0.35700	22.3000	14.30000	200	F
Dibenz(a,h)anthracene	1.16000	4.4600	5.84000	200	
Fluoranthene	1.58000	31.2000	48.80000	200	
Fluorene	1.12000	31.2000	4.71000	200	F
Indeno(1,2,3-cd)pyrene	0.53500	6.6900	7.75000	200	
Naphthalene	2.90000	268.0000	2.90000	200	U
Phenanthrene	0.51300	9.3700	21.50000	200	
Pyrene	1.25000	40.1000	48.40000	200	

Surrogate	Recovery	Control Limits	Qualifier
p-Terphenyl (SS)	0.0	22.0 - 167	

Comments:

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C1 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB3 .N1 Lab Sample ID: D97-14995-13 Matrix: Soil

% Solids: 89.7 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.31200	2.0100	10.80000	200	
Benzo(a)pyrene	0.40100	3.3500	17.70000	200	
Benzo(b)fluoranthene	0.49100	2.6800	14.90000	200	
Benzo(k)fluoranthene	0.53500	2.4500	9.76000	200	
Dibenz(a,h)anthracene	1.16000	4.4600	5.84000	200	
Indeno(1,2,3-cd)pyrene	0.53500	6.6900	7.75000	200	
Pyrene	1.25000	40.1000	48.40000	200	

Comments:

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 8310 C2 Preparatory Method: EPA 3550A AAB #: AC292-72A

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB3 N1 Lab Sample ID: D97-14995-13 Matrix: Soil

% Solids: 89.7 Initial Calibration ID: PAH010798

Date Received: 10-DEC-1997 Date Extracted: 16-DEC-1997 Date Analyzed: 20-JAN-1998

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Benzo(a)anthracene	0.31200	2.0100	11.60000	200	
Benzo(a)pyrene	0.40100	3.3500	18.50000	200	
Benzo(b)fluoranthene	0.49100	2.6800	21.10000	200	
Benzo(k)fluoranthene	0.53500	2.4500	5.87000	200	
Dibenz(a,h)anthracene	1.16000	4.4600	24.10000	200	
Indeno(1,2,3-cd)pyrene	0.53500	6.6900	17.30000	200	
Pyrene	1.25000	40.1000	20.40000	200	F

Comments:

AFCEE FORM O-2

3015 A

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-16

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB7 N1 Lab Sample ID: D97-14995-1 Matrix: Soil

% Solids: 79.9 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	18.80	31.3	18.80	1	U

Comments:

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-16

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB1 N1 Lab Sample ID: D97-14995-2 Matrix: Soil

% Solids: 81.0 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	37.00	61.7	395.00	2	

Comments:

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-16

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB1 N1 Lab Sample ID: D97-14995-3 Matrix: Soil

% Solids: 76.6 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	19.60	32.6	19.60	1	U

Comments:

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB6 N1 Lab Sample ID: D97-14995-4 Matrix: Soil

% Solids: 80.1 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	18.70	31.2	130.00	1	

Comments:

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB6 N1 Lab Sample ID: D97-14995-5 Matrix: Soil

% Solids: 78.0 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	19.20	32.0	19.20	1	U

Comments:

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB5 N1 Lab Sample ID: D97-14995-6 Matrix: Soil

% Solids: 77.4 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	19.40	32.3	19.40	1	U

Comments:

AFCEE FORM O-2

4001-07

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB5 N1 Lab Sample ID: D97-14995-7 Matrix: Soil

% Solids: 75.7 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	19.80	33.0	19.80	1	U

Comments:

AFCEE FORM O-2

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB4 N1 Lab Sample ID: D97-14995-8 Matrix: Soil

% Solids: 80.3 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	18.70	31.1	181.00	1	

omments:

AFCEE FORM O-2

400:-09

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB4 N1 Lab Sample ID: D97-14995-9 Matrix: Soil

% Solids: 80.0 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	93.80	156.0	1030.00	5	

Comments:

AFCEE FORM O-2

400i-10

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB2 N1 Lab Sample ID: D97-14995-10 Matrix: Soil

% Solids: 81.8 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	18.30	30.6	18.30	1	U

Comments:

AFCEE FORM O-2

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB2 N1 Lab Sample ID: D97-14995-11 Matrix: Soil

% Solids: 78.3 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	19.10	31.9	19.10	1	U

Comments:

AFCEE FORM O-2

4001-12

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB3 N1 Lab Sample ID: D97-14995-12 Matrix: Soil

% Solids: 83.1 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	18.10	30.1	53.80	1	

omments:

AFCEE FORM O-2

4001-13

AFCEE
ORGANICS ANALYSIS DATA SHEET 2
RESULTS

Analytical Method: EPA 418.1 mod. Preparatory Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Field Sample ID: OF4-CSB3 N1 Lab Sample ID: D97-14995-13 Matrix: Soil

% Solids: 89.7 Initial Calibration ID:

Date Received: 10-DEC-1997 Date Extracted: 23-DEC-1997 Date Analyzed: 23-DEC-1997

Concentration Units (ug/L or mg/kg dry weight) : mg/Kg

Analyte	MDL	RL	Concentration	Dilution	Qualifier
Total Petroleum Hydrocarbon	16.70	27.9	93.70	1	

Comments:

AFCEE FORM O-2

AFCEE
ORGANICS ANALYSIS DATA SHEET 6
BLANKS

Analytical Method: EPA 418.1 mod. AAB #: AC324-15

Lab Name: ITS Environmental Contract:

Units: mg/Kg Method Blank ID: D97-14995-15

Analyte	PQL	Method Blank	Qualifier
Total Petroleum Hydrocarbon	25.0	15.00	U

Comments:

AFCEE FORM O-6

400i-15

APPENDIX C
CALCULATIONS

Table C-1
Computaion of Risk Based Screening Levels

Compound	Csat (mg/kg)	$RBSL_{air}$ (µg/m³) Carc.	$RBSL_{air}$ (µg/m³) Non Carc	Dseff	Dcrackeff	VFseep	Subsurface soil to indoor air RBSLs (mg/kg) Carc.	Subsurface soil to indoor air RBSLs (mg/kg) Non Carc
Volatiles								
Benzene	850	4.93E-01		7.26E-03	7.26E-03	3.09E-02	1.60E-02	
Toluene	768		5.62E+02	6.63E-03	6.63E-03	1.07E-02		5.25E+01
Ethylbenzene	163		1.48E+03	5.93E-03	5.93E-03	1.61E-02		9.18E+01
m,p-Xylenes	435		1.02E+04	5.62E-03	5.62E-03	5.87E-03		1.74E+03 RES
o-Xylene	447		1.02E+04	5.62E-03	5.62E-03	5.87E-03		1.74E+03 RES
PAHs								
Acenaphthene	208		3.07E+02	3.29E-03	3.29E-03	3.87E-06		7.93E+04 RES
Anthracene	10		1.53E+03	2.55E-03	2.55E-03	2.63E-07		5.84E+06 RES
Fluorene	150		2.04E+02	2.85E-03	2.85E-03	8.88E-07		2.30E+05 RES
Naphthalene	402		2.04E+01	5.62E-03	5.62E-03	1.92E-04		1.06E+02

Calculated using oral toxicity values for inhalation

Carcinogenic $RBSLair = \frac{TR \times BW \times AT_{carc} \times 356\ (d/yr) \times 1000\ (mg/mg)}{SFi \times IR \times EF \times ED}$

Noncarcinogenic $RBSLair = \frac{THQ \times RfD_i \times AT_{noncarc} \times 356\ (d/yr) \times 1000\ (mg/mg)}{SFi \times IR \times EF \times ED}$

$RBSLs = \frac{RBSLair \times 10^{-3}\ (mg/\mu g)}{VFseep}$

$VFseep = \frac{(h \times \rho_s)/(\theta_{ws} + k_s \times \rho_s + H \times \theta_{as})\ (D_s^{eff}/L_s/ER/L_b) \times 1000\ (cm^3\text{-}kg/m^3\text{-}g)}{1 + (D_s^{eff}/L_s/ER/L_b) + [D_s^{eff}/L_s/(D_{crack}^{eff}/L_{crack})/\eta]}$

$D_s^{eff} = D_{air} \times (\theta_{as}^{3.33}/\theta_T^2) + D_{wat}/H \times (\theta_{ws}^{3.33}/\theta_T^2)$

$D_{crack}^{eff} = D_{air} \times (\theta_{acrack}^{3.33}/\theta_T^2) + D_{wat}/H \times (\theta_{wcrack}^{3.33}/\theta_T^2)$

Table C-2
Computaion of Risk Based Screening Levels

Compound	Csat (mg/kg)	$RBSL_{air}$ (µg/m³) carc	$RBSL_{air}$ (µg/m³) Non Carc	Dseff	Dcrackeff	VFseep	Subsurface soil to indoor air RBSLs (mg/kg) Carc.	Subsurface soil to indoor air RBSLs (mg/kg) Non Carc	
Volatiles									
Benzene	850	1.23E+00		5.18E-03	5.18E-03	1.63E-02	7.57E-02		
Toluene	768		1.41E+03	4.73E-03	4.73E-03	6.65E-03		2.11E+02	
Ethylbenzene	163		3.70E+03	4.23E-03	4.23E-03	9.76E-03		3.80E+02	RES
m,p-Xylenes	435		2.56E+04	4.01E-03	4.01E-03	3.78E-03		6.75E+03	RES
o-Xylene	447		2.56E+04	4.01E-03	4.01E-03	3.78E-03		6.75E+03	RES
PAHs									
Acenaphthene	208		7.67E+02	2.49E-03	2.35E-03	2.63E-06		2.91E+05	RES
Anthracene	10		3.83E+03	2.16E-03	1.82E-03	1.81E-07		2.11E+07	RES
Fluorene	150		5.11E+02	2.39E-03	2.03E-03	6.11E-07		8.36E+05	RES
Naphthalene	402		5.11E+01	4.03E-03	4.01E-03	1.29E-04		3.95E+02	

Calculated using oral toxicity values for inhalation

Carcinogenic RBSLair =

$$\frac{TR \times BW \times AT_{carc} \times 356\ (d/yr) \times 1000\ (mg/mg)}{SFi \times IR \times EF \times ED}$$

Noncarcinogenic RBSLair =

$$\frac{THQ \times RfD_i \times AT_{noncarc} \times 356\ (d/yr) \times 1000\ (mg/mg)}{SFi \times IR \times EF \times ED}$$

RBSLs =

$$\frac{RBSLair \times 10^{-3}\ (mg/\mu g)}{VFseep}$$

VFseep =

$$\frac{(h \times \rho_s)/(\theta_{ws} + k_s \times \rho_s + H \times \theta_{as})\ (D_s^{eff}/L_s/ER/L_b) \times 1000\ (cm^3\text{-}kg/m^3\text{-}g)}{1 + (D_s^{eff}/L_s/ER/L_b) + [D_s^{eff}/L_s/(D_{crack}^{eff}/L_{crack})/\eta]}$$

$$D_s^{eff} = D_{air} \times (\theta_{as}^{3.33}/\theta_T^2) + D_{wat}/H \times (\theta_{ws}^{3.33}/\theta_T^2)$$

$$D_{crack}^{eff} = D_{air} \times (\theta_{acrack}^{3.33}/\theta_T^2) + D_{wat}/H \times (\theta_{wcrack}^{3.33}/\theta_T^2)$$

Table C-3
Parameters used in Development of Risk Based Screening Levels and Site Specific Target Levels

Parameter	Definitions	Units	RBSL Tier I comm/ind	SSTL Tier II comm/in
IR	Inhalation rate	m^3/d	20	20
EF	Exposure frequency	d/yr	250	250
ED	Exposure duration	year	25	10
TR	Target Risk	-	1.00E-06	1.00E-06
BW	Body weight	kg	70	70
THQ	Target hazard quotient	-	1	1
ATcarc	Averaging time for carcinogens	year	70	70
ATnonc	Averaging time for noncarcinogens	year	25	25
ER	Air exchange rate	1/sec	0.00023	0.00023
f_{oc}	Fraction of organic carbon in soil	gram/gram	0.01	0.01
k_s	Soil-water sortpion coefficient		$f_{oc} \times k_{oc}$	$f_{oc} \times k_{oc}$
L_b	Enclosed space volume/infiltration area	cm^3/cm^2	300	300
L_{crack}	Enclosed space foundation/wall thickness	cm	15	15
L_s	Depth to subsurface soil sources	cm	100	180
η	Areal fraction of cracks in foundation/wall	cm^2/cm^2	0.01	0.01
θ_{acap}	Volumetric air content in capillary fringe soils	cm^3/cm^3	0.038	0.038
θ_{crack}	Volumetric air content in foundation/wall cracks	cm^3/cm^3	0.26	0.26
θ_{as}	Volumetric air content in vadose zone soils	cm^3/cm^3	0.26	0.12
θ_T	Total soil porosity	cm^3/cm^3	0.38	0.45
θ_{wcap}	Volumetric water content in capillary fringe soils	cm^3/cm^3	0.342	0.412
θ_{wcrack}	Volumetric water content in foundation/wall crack	cm^3/cm^3	0.12	0.12
θ_{ws}	Volumetric water content in vadose zone soils	cm^3/cm^3	0.12	0.33
ρ_s	Soil bulk density	$gram/cm^3$	1.7	1.46

Table C-4
Properties of Compounds Evaluated

Compound	MW g/mol	S (mg/L)	H atm/m3/mol)	H'	Dair (cm2/s)	Dw (cm2/s)	log(Koc)	log(Kow	SFo (mg/kg/d)	SFi (mg/kg/d)	RfDo	RfDi
Volatiles												
Benzene	78	1.75E+03	5.56E-03	0.228	0.093	1.10E-05	1.58	2.13	2.9E-02	2.9E-02		
Toluene	92	5.26E+02	6.34E-03	0.26	0.085	9.40E-06	2.13	2.65		na	2.0E-01	0.11
Ethylbenzene	106	1.52E+02	7.88E-03	0.323	0.076	8.50E-06	1.98	3.13		na	1.0E-01	0.29
m,p-Xylenes	106	1.73E+02	7.07E-03	0.29	0.072	8.50E-06	2.38	3.26		na	2.0E+00	2
o-Xylene	106	1.78E+02	7.07E-03	0.29	0.072	8.50E-06	2.38	3.26		na	2.0E+00	2
PAHs												
Acenaphthene	154	4.24E+00	1.55E-04	6.36E-03	4.21E-02	7.69E-06	3.69	3.92		na	6.0E-02	6.0E-02
Anthracene	178	4.34E-02	6.51E-05	2.67E-03	3.24E-02	7.74E-06	4.37	4.55		na	3.0E-01	3.0E-01
Fluorene	166	1.98E+00	6.37E-05	2.61E-03	3.63E-02	7.88E-06	3.88	4.21		na	4.0E-02	4.0E-02
Naphthalene	128	3.10E+01	1.20E-03	4.90E-02	7.20E-02	9.40E-06	3.11	3.28		na	4.0E-02	4.0E-03

Table C-5
Tier 3 evaluation

Equations	Input Parameters		
Equilibrium Partitioning: Vapor Phase above Dissolved Contamination	$C_{v,eq}$	Equilibrium vapor concentration (g/cm^3)	chemical-specific
$C_{v,eq} = (H*C_{w,eq})$	H	Henry's law constant (dimensionless)	chemical-specific
	$C_{w,eq}$	Equilibrium dissolved concentration (g/ml)	chemical-specific
Equilibrium Partitioning: Vapor Phase above LNAPL	x_i	Mole fraction of contaminant i	chemical-specific
$C_{v,eq}=(x_iP_vM_w/RT)$	P_v	Vapor pressure of contaminant i (atm)	chemical-specific
	M_w	Molecular weight (g/mol)	chemical-specific
Equilibrium Partitioning: Vapor Phase in Contaminated Soils	RT	Gas constant*temperature (cm^3-atm/mol)	2.44E+04
$C_{v,eq} = (HC_{soil}p_s)/(\phi_w+k_sp_s+H\phi_a)$	C_{soil}	Concentration of contaminant in soil (g/g-soil)	chemical-specific
	p_s	Soil bulk density (g-soil/cm^3-soil)	1.46
Measured Vapor Phase in Soils	ϕ_w	Volumetric content of pore water (dimensionless)	0.33
$C_{v,eq}$ = Maximum measured soil gas concentration	k_s	Sorption coefficient (cm^3-H_2O/g-soil)	chemical-specific
	ϕ_a	Volumetric content of pore vapor (dimensionless)	0.12
Effective Vapor Diffusion Coefficient	ϕ_T	Total volumetric content in soil (dimensionless)	0.45
$D^{eff} = (\phi_a^{3.33}/\phi_T^{3.33})*D_{air} + (1/H)*(\phi_w^{3.33}/\phi_T^{3.33})*D_w$	D_{air}	Diffusion coefficient in air (cm^2-day)	chemical-specific
	D_w	Diffusion coefficient in water (cm^2/day)	chemical-specific
Maximum Vapor Flux to Open Space	R_v	Porous media retardation (dimensionless)	k_s*p_s
$F_{max} = R_vu_{v,max}C_{v,eq} - (R_vu_{v,max}C_{v,eq})/[1-\exp(R_vu_{v,max}d/D^{eff})]$	$u_{v,max}$	Convective transport of vapors (cm/day)	100
	d	Distance below ground to source (cm)	183
Ambient Outdoor Concentration (g/cm^3)	L	Downwind length of source area (cm)	2740
$C_{outdoor} = F_{max}L/u_w\delta$	u_w	Wind speed (cm/day)	1.94E+07
	δ	Breathing height (cm)	1.89E+02
Maximum Vapor Flux to Enclosed Space	A_{bldg}	Surface area of building (cm^2)	1.30E+07
$E_{max} = (D^{eff}C_{v,eq}\phi_a^{3.33})/(\phi_T^2d)$	F_{crack}	Fraction of cracks in foundation (dimensionless)	0.01
	Air_{exch}	Air exchanges per day	10
Ambient Indoor Concentration (g/cm^3)	V_{bldg}	Volume of building (cm^3)	3.17E+09
$C_{indoor} = (E_{max}A_{bldg}F_{crack})/(Air_{exch}V_{bldg}MF)$	MF	Mixing factor (dimensionless)	0.5

Compound	H	x_i	P_v	M_w	C_{soil}	D_{air}	D_w	k_s	Deff	Emax	Cv,eq soil	Predicted $C_{v,eq}$	C_{indoor} (mg/m^3)
Benzene	0.228	0.000	0.125	78	4.42E-06	8.04E+03	0.95	0.380	99.989	3.7347E-09	1.61253E-06	1.61E-06	3.06E-05
		no product											